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WATER SUPPLY & SEWAGE DISPOSAL
IN RURAL DISTRICTS

AND

PLUMBERS' WORK

IN ITS RELATION TO

TOWN AND COUNTRY HOUSES

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SALUS GENERIS HUMANI.

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THE ROYAL SOCIETY

WATER SUPPLY & SEWAGE DISPOSAL IN RURAL DISTRICTS

AND

PLUMBERS' WORK

IN ITS RELATION TO

TOWN AND COUNTRY HOUSES

Being the Reports of The Lancet Special Commissions on these Subjects.

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NOTE.

In issuing under one cover the Reports of two Commissions appointed to inquire into certain subjects of the first importance to the public health, the Proprietors of The Lancet desire to obtain for the investigations and resulting conclusions a wider circle of readers than could be found amongst those subscribing to a technical journal.

They believe that the publication of these Reports in their present form may interest many citizens not belonging to the medical profession, and may thereby help to educate public opinion on matters nearly concerning the general good.

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PART I.

REPORT OF

The Lancet Special Commission

ON THE

RELATIVE EFFICIENCY & COST

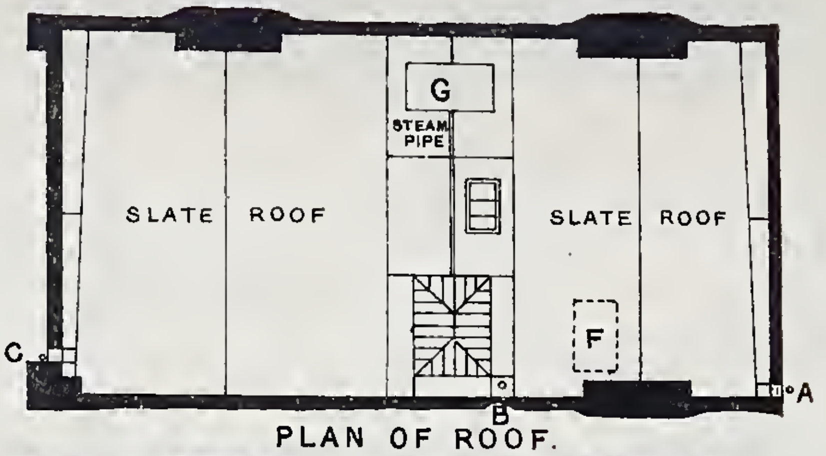
OF

PLUMBERS' WORK

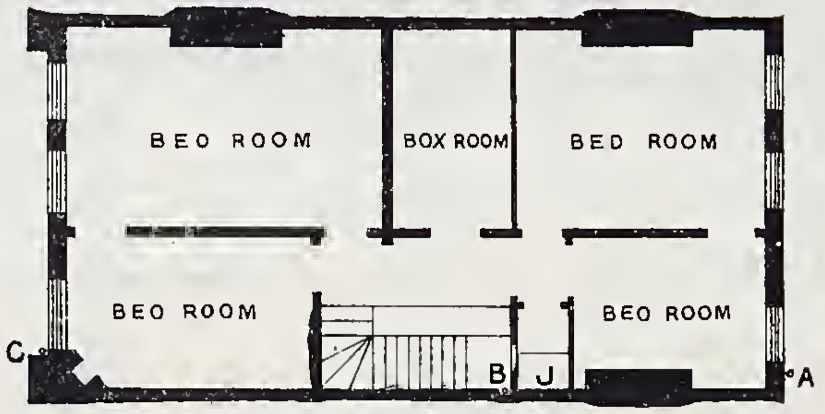
[*THE LANCET, JULY 4, 1896.*]

EXAMPLE I.

A Rain-water pipe, Par. 2.
B ,, ,, Par. 4; also soil-pipe from J.
C Rain-water pipe, Par. 6; also soil-pipe from M.
D Rain-water pipe, Par. 8.
E ,, ,, Pars. 9 and 59.
F Lead-lined cistern in roof, Par. 11.
G Slate cistern on lead flat, Par. 13.
H Lead-lined cistern in cupboard, par 17.
I Cast-lead cistern in area, Par. 19.
J Pan closet, Par. 22.
K Old valve closet, Par. 25.
L Bramah closet, Par. 27.
M Side wash-out closet, Par. 29.
N Hopper closet, Par. 31.
O ,, ,, Par. 33.
P Soil-pipe, Par. 35.
Q Housemaid's sink under stairs, Par. 38.
R Sink (scullery), Par. 41.
S ,, (servants' hall), Par. 43.
T ,, pantry, Par. 45.
U ,, (housekeeper's room), Par.47.
V Bath, Par. 49; also Par. 35.
W Bell-traps under boiler taps, Pars. 56 and 63.
X Iron D-trap, Par. 59.
Y Iron bell-trap, Par. 65.
Z Brick-built dip-trap, Par. 66.
AA Hot-water cistern, Par. 52.



PLAN OF ROOF.



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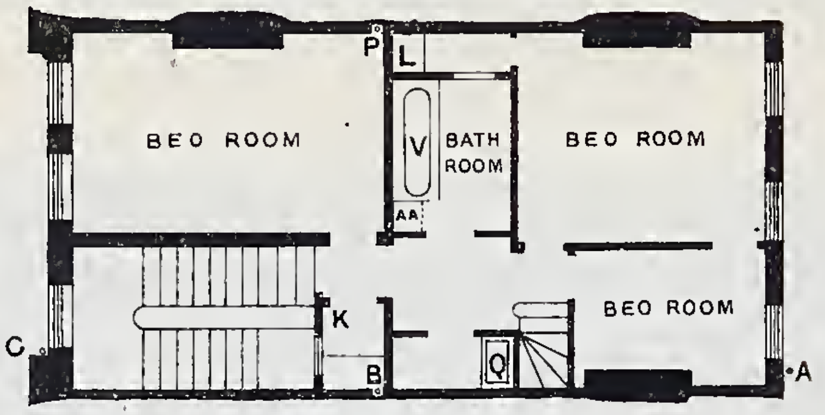

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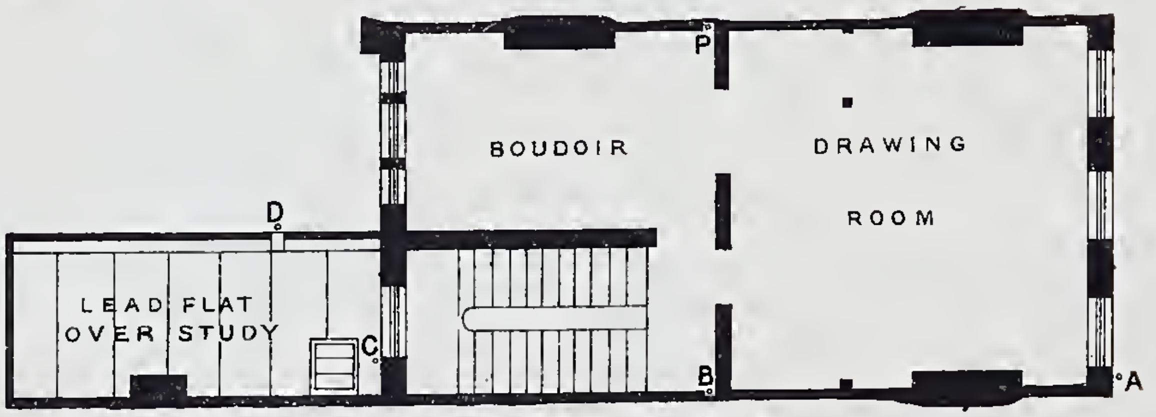

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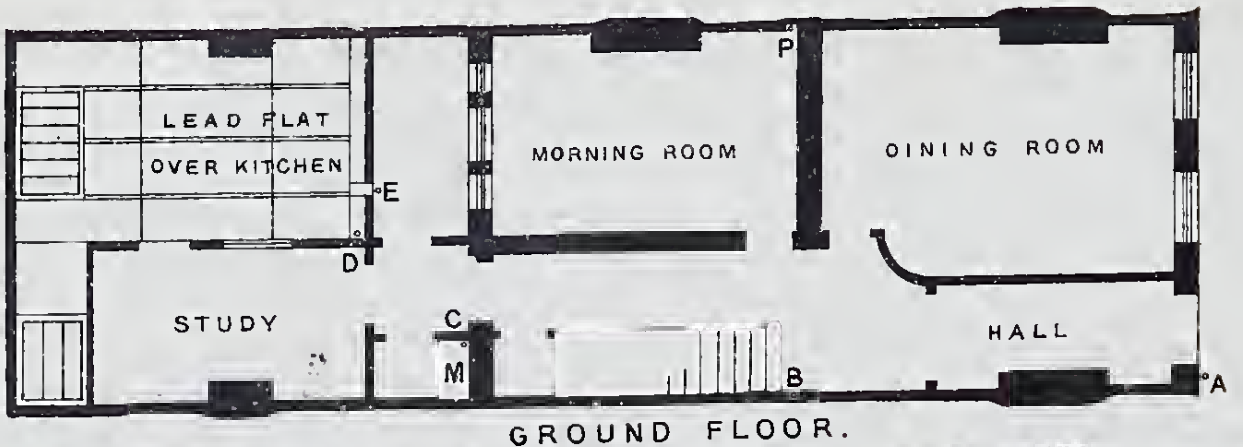

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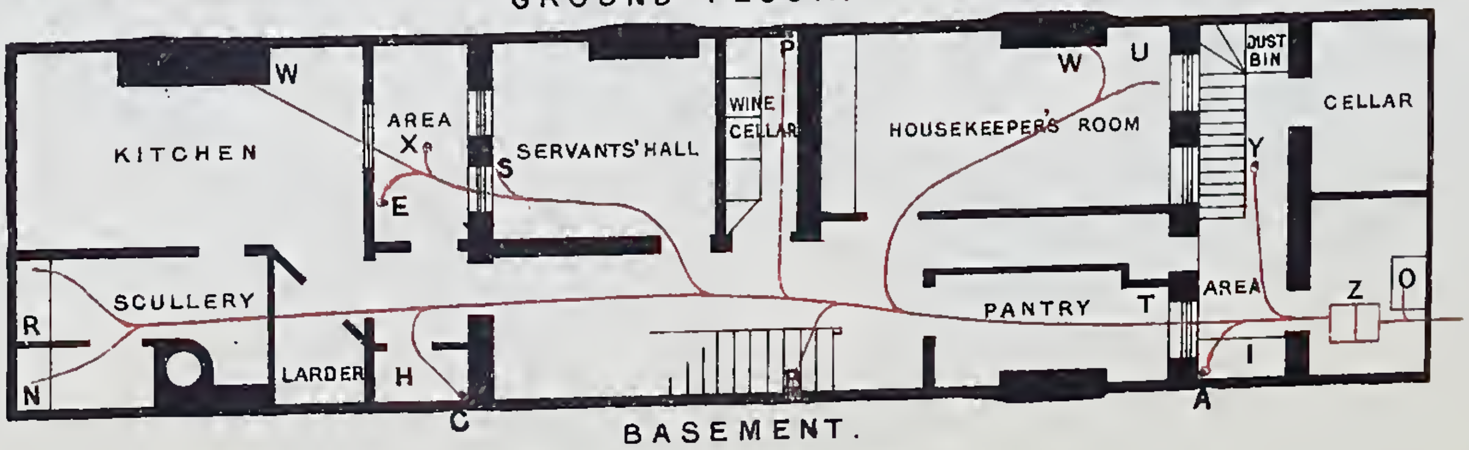
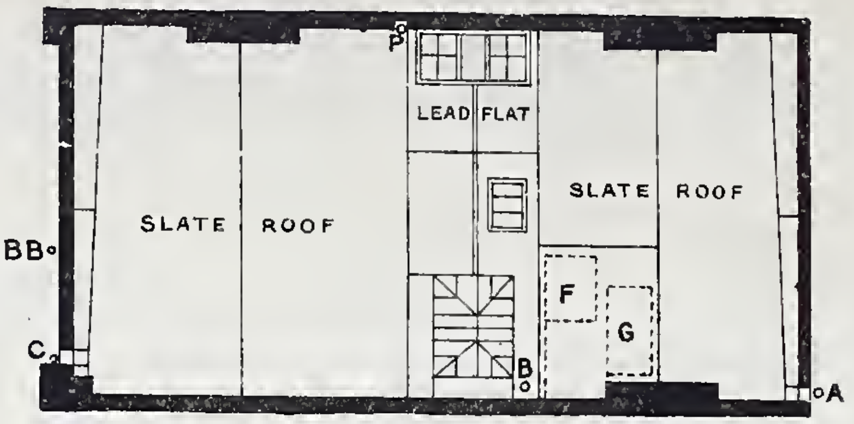


BASEMENT.

EXAMPLE No 1.

EXAMPLE I.—CORRECTED

A Rain-water pipe, Par. 3, over **FF**.
B „ „ Par. 5, over **FF**; also waste of **V**, see Par. 51, into **X**.
C Rain-water pipe, Par. 7.
D „ „ Par. 8.
E „ „ Par. 10, over flushing gully.
F Lead-lined cistern, Par. 12; supplies **J**, **K**, **M**, **N**.
G Galvanised iron cistern, Pars. 14, 15, and 16; supplies sinks.
H Galvanised iron cistern, Par. 18; supplies scullery sink.
I Galvanised iron cistern, Par. 20; supplies **O**.
J Pedestal closet, Par. 24.
K Valve closet, Par. 26.
L Removed; see Par. 28.
M Pedestal closet, Par. 30.
N „ „ Par. 32, for women.
O Pedestal closet, Par. 34, for men.
P Bath waste into **X**, Pars. 35 and 51.
Q Sink (housemaid's), Par. 40.
R Sink (scullery), Par. 42, into flushing gully.
S Sink (servants' hall), Par. 44, into **Y**.
T Sink (pantry), Par. 46, into **FF**.
U Sink (housekeeper's room), Par. 48, into **HH**.
V Bath, Par. 49, into **X**; see Par. 51.
W Gully, disconnected over **HH**.
X „ Par. 69; see **V**, Par. 51.
Y „
Z Inspection chamber, Par. 70.
AA Gully, with disconnected drain into flushing gully.
BB Soil and ventilating pipe, Par. 36.
CC Disconnecting chamber, Par. 67; also see Note zii and Figs. 27 and 28.
DD Gully.
EE Air inlet.
FF Gully, Par. 3.
GG Eye for testing drain.
HH Gully.
II Position of H.W. cylinder. Par. 53.



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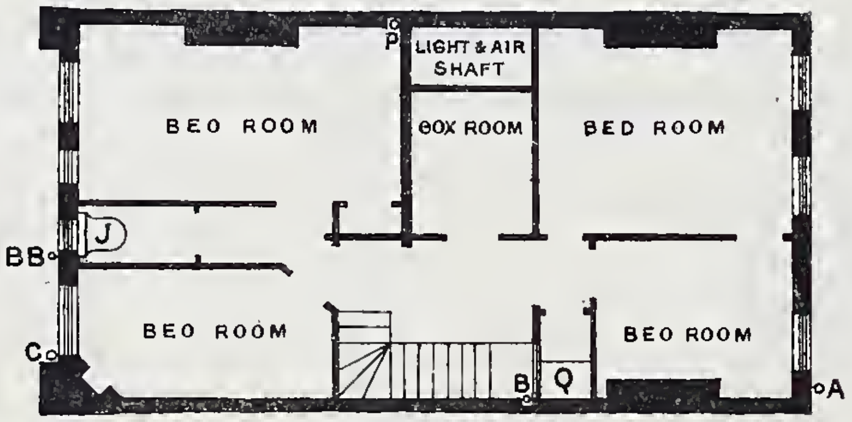

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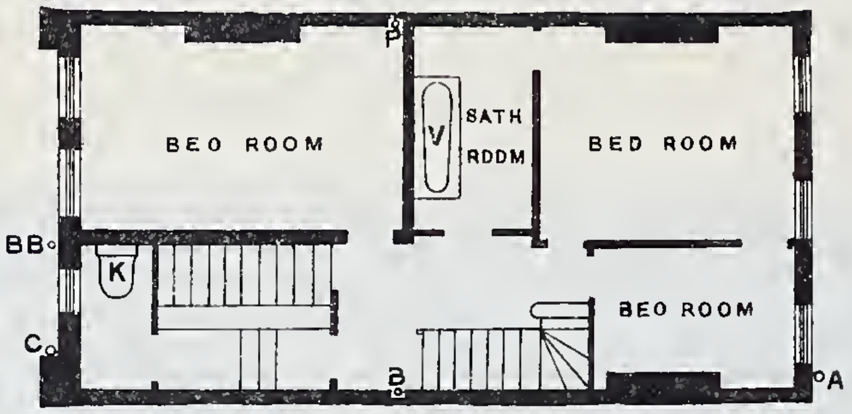

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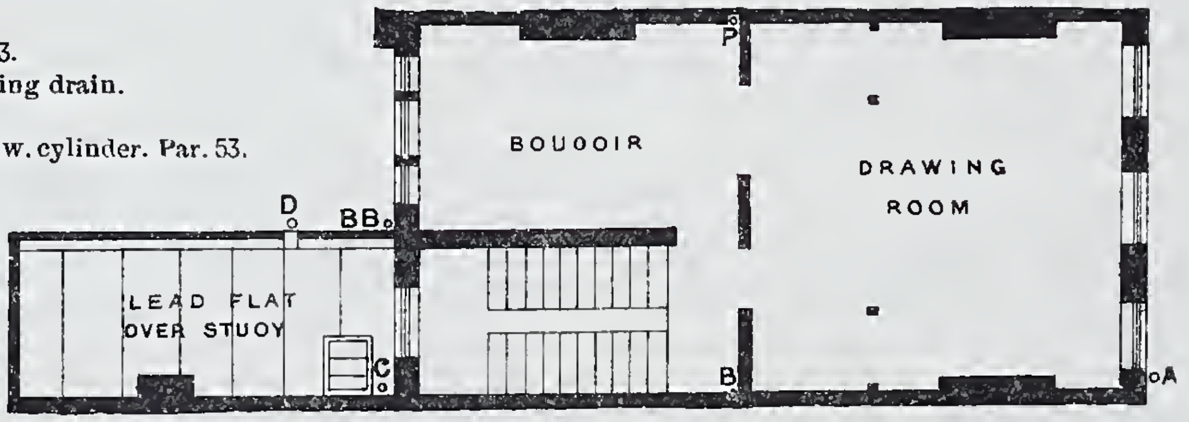

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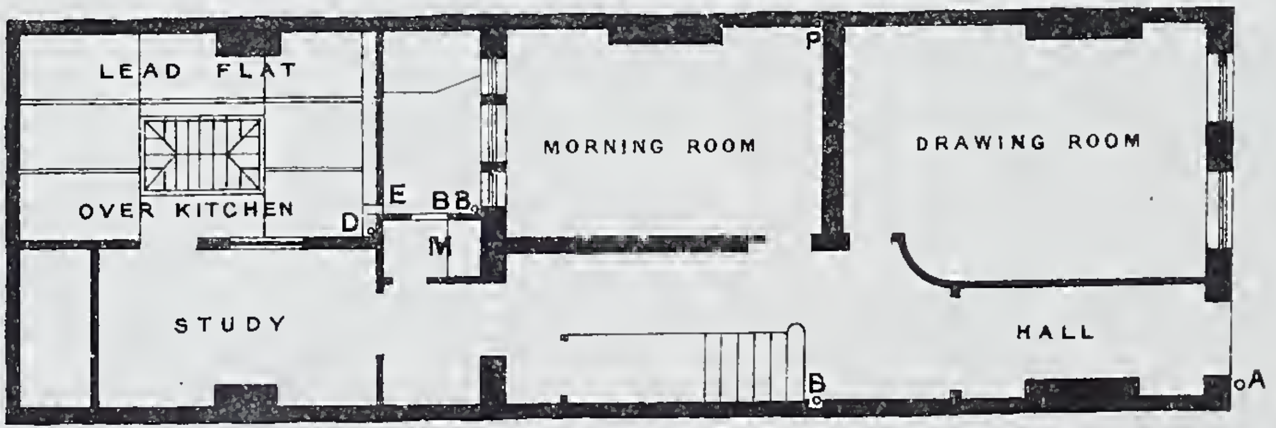

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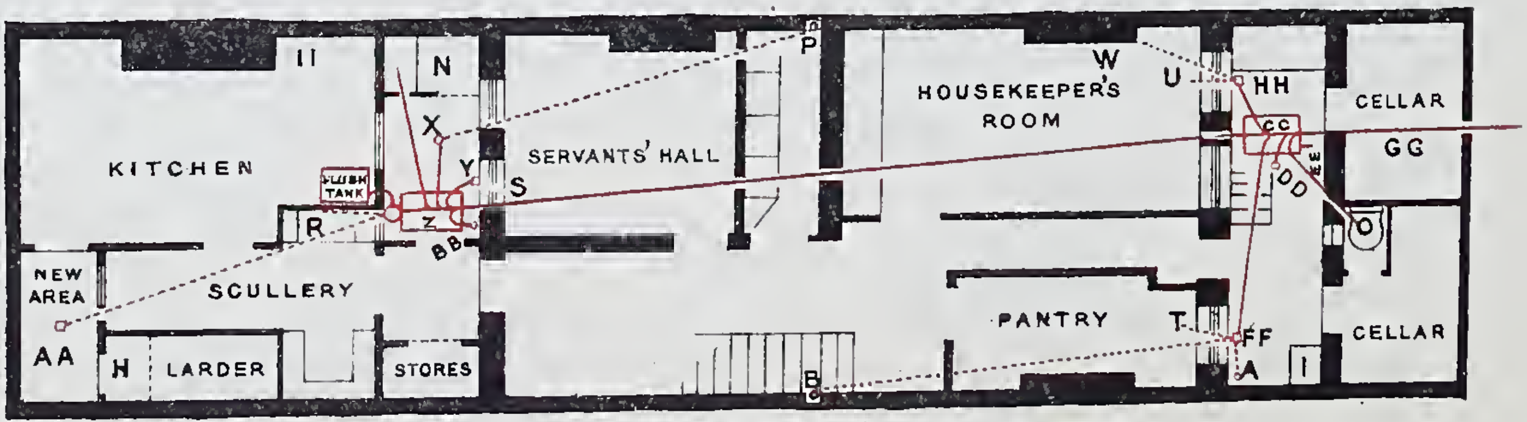


BASEMENT.

EXAMPLE No. I. CORRECTED.

REPORT OF

The Lancet Special Commission

ON THE

RELATIVE EFFICIENCY AND COST

OF

PLUMBERS' WORK.

IN placing before the readers of THE LANCET the result of the labours of our Commissioners appointed to investigate the subject of the "Relative Efficiency and Cost of Plumbers' Work," and the criticisms and suggestions of the Special Committee of the Worshipful Company of Plumbers appended thereto, we may state that we had hoped to have published these conclusions some time ago, but the enquiry has taken longer than we anticipated. Few can be aware of the vast amount of detail with which both our Commissioners and the Committee appointed by the Plumbers' Company have had to deal, and we desire to express to them our thanks for the thoroughness with which they have considered the matter, and also for the large amount of time and labour ungrudgingly placed at our disposal.

We have been favoured with the following communication from the Plumbers' Company:—

The Worshipful Company of Plumbers.

1, Adelaide-buildings, London-bridge,
London, E.C., June 3rd, 1896.

To the Editors of THE LANCET.

GENTLEMEN,—I have the honour to hand you the report of the Committee appointed by the Worshipful Company of Plumbers to consider the report of an enquiry undertaken by you into the subject of "The Relative Efficiency and Cost of Plumbers' Work."

In publishing the same I have to request you to let it appear as the work of a Special Committee appointed by the Company for the purpose, and not as the work of the Company. The reason for this request is that the Company does not, in its corporate capacity, take any part in what may be regarded as "trade matters," but directs its efforts entirely to promoting the sound technical instruction of plumbers combined with the necessary arrangements for establishing an adequate system of registration and control over those men who are registered as qualified plumbers. The subject of "the cost of plumbers' work" is outside the purview of the Company's objects, but as it manifestly has an important bearing upon the sanitary efficiency of the work, the Company have had pleasure in appointing a Committee in accordance with your desire, believing that the information you propose to publish may convey useful information to members of the medical profession who are interested in the preservation of the public health, and serve a highly important public object.

I am, Sirs, yours truly,

W. R. E. Coles, Clerk.

REPORT OF THE SPECIAL COMMITTEE APPOINTED BY THE WORSHIPFUL COMPANY OF PLUMBERS TO OFFER CRITICISM AND SUGGESTIONS UPON THE REPORT OF AN ENQUIRY UNDERTAKEN BY THE LANCET INTO THE SUBJECT OF THE "RELATIVE EFFICIENCY AND COST OF PLUMBERS' WORK."

In compliance with your desire that the Worshipful Company of Plumbers should appoint a committee to criticise and offer suggestions on the report you are about issuing, embodying the result of the inquiry you have made into the efficiency and cost of plumbing work, we have, at the request of the company, acted as an independent committee to deal with the matter, as the company do not take any part in questions relating to prices or other trade matters outside those connected with the training and registration of plumbers. We have examined the proof copy of your report with drawings and schedule of prices connected therewith, and we find :—

1. That the reasons stated in your report for the frequency of bad, defective, and insanitary work are generally correct.

2. That the defects indicated as existing in the typical houses dealt with in your report are of the kind commonly met with, although rarely, if ever, present in the same building at the same time, for houses so insanitary would probably be uninhabitable, therefore the defects may be assumed to be grouped under one roof merely for the purpose of illustration.

3. That the recommendations which are made in your report for new and altered work, respectively, are consistent with the requirements of modern sanitation and fairly represent the sound plumbing practice of the present day, except in some few comparatively unimportant instances (see Notes appended hereto).

4. That the prices and particulars stated in the estimates attached to your report are approximately correct for sound work in conformity with modern sanitary requirements carried out in houses of the construction illustrated in your drawings and situated in London. Prices for work executed out of London vary considerably—sometimes downward, from local wages being lower than those paid in London, sometimes upward, from travelling expenses and allowances being paid to workmen.

5. That the prices stated are liable to increase apart from fluctuations in the price of materials—some items to considerable increase, if the work specified were carried out in sections instead of at one time, as contemplated in your report.

6. That the report, taken as a whole, may be regarded as a unique work on the subject of the efficiency and cost of plumbing work, and is calculated, if studied attentively, to assist members of the medical profession, sanitary authorities, and others in arriving at a more correct judgment than

commonly prevails as to the chief causes of the defective and insanitary plumbers' work frequently met with, and to afford them some useful information as to the cost of plumbing work which is sound in construction and sanitary in character. We are, moreover, of opinion that the Editors of THE LANCET are entitled to credit for having set on foot the first impartial and systematic inquiry into the matter, and especially for having grappled with the thorny and difficult question of *price*, which has an obvious, though often ignored, bearing on the *efficiency* of plumbers' work.

The committee desire to accompany these conclusions and findings of fact with the following observations and suggestions:—

(*a*) That, while there is no doubt that the prices set forth in the estimates may be, in some instances, higher than those estimated by well-known architects and surveyors, it is to be remarked that the prices which govern the estimates of these professional gentlemen are, as indicated in the report, mainly the prices quoted by persons tendering for work in keen competition and not those derived from knowledge of the actual cost of materials or of workmanship.

(*b*) That the cost of plumbers' work, even of the highest class, is comparatively a small item in relation to the total cost of a new house, and it has grown to be regarded as the item which can be squeezed down to the lowest limit, because the work of the plumber is less observable than the decorative or other part of the house which affects its letting value.

(*c*) That the prices of the accompanying estimates would yield but a moderate profit to the master plumber carrying on a large business with adequate capital, and at full trades union rates, but moderate wages to the workmen practising a skilled trade like plumbing, in which men are early incapacitated, from the character of their work, from following their calling, and are moreover liable to considerable sickness and a rate of mortality higher than in other branches of the building trades. (See statistics of Drs. Ogle, Farr, and Eben. Duncan.)

(*d*) That the best class of work, requiring more supervision and involving more labour and anxiety, leaves a relatively smaller margin of profit than work of an inferior kind, and from unforeseen difficulties in estimating for plumbers' work it has, in the experience of the committee, been carried out in not a few instances without profit, and in some cases at an actual loss, in order that it should not be below the standard of work creditable to a firm of reputation.

(*e*) That the class of work which the competent plumber would wish to do to meet the requirements of medical and sanitary authorities can only be efficiently carried out by men having had lengthened training as plumbers and experience in sanitary work.

(*f*) That the work of the plumber is of such a nature, and is now recognised as having so important a bearing on the health of the community, that it cannot reasonably be classed with other branches of the building trade and should be carried out under special regulations recognised by the authorities under the Public Health Acts.

(*g*) That the discrepancies frequently complained of in the cost of plumbers' work arise largely from differences in the construction of houses, the smallness of the jobs executed at one time involving loss of time to men going to and from work, and other special items of cost, and from other causes over which the plumber has no control.

(*h*) That the estimates accompanying the report should be useful as setting up a standard of approximate prices of sound sanitary work.

(*i*) That plumbers should be called to assist sanitary authorities in formulating regulations dealing with sanitary appliances and water fittings. To quote the words of Dr. Alfred Hill, medical officer to the corporation of Birmingham, in reference to the relation of the plumber to the sanitary authorities: "It is no use to have good sanitary arrangements and sanitary inspectors unless the plumbing work is well done. The health committees want really to make the plumbers their technical assistants."

(*j*) That architects are often placed in a difficult position by the difficulty of getting their clients to realise the importance of sound sanitary work, and therefore the plumber should be more directly responsible for the efficiency of his work.

NOTES.

Illustration, Fig. 27.—The form of trap shown is not the most approved. A trap of this kind should have a "cascade" action given by a vertical fall of not less than 3 in., causing the trap to be more efficiently cleansed. The fall shown in the channel pipe is also more than is necessary, 3½ in. being sufficient. It is noticeable that no allusion is made to the combined system of drainage which is known to exist in many instances, although highly objectionable.

Paragraph 16.—The deep trap in cold water service to cylinder is unnecessary.

Paragraph 36.—10 lb. soil pipe recommended is unduly heavy, 8 lb. being generally sufficient. In many cases 6 tacks are unnecessary, 4 being sufficient; they should be not less than three-sixteenths of an inch in thickness. The number of tacks to be used depends upon the position of the pipe.

Paragraph 45, Note S.--Where cost is not of the first importance tinned copper will be found the best material with which to line this sink.

Paragraph 50.—Enamelled copper is preferable to iron where the expense will allow, the additional cost being about £5 or £6.

Paragraph 53.—The insertion of the return pipe from top of house to cylinder is shown in Fig 23 too low down. A great advantage is derived from placing a stop-cock in this pipe, to be turned off when the fire is let out, as it prevents loss by radiation by the water circulating during the night. A by-pass to connect the flow from the boiler to that from the cylinder will also be found an advantage for obtaining hot water rapidly after the fire is lighted. No particular boiler or details of the connexions are given, although the character of the boiler and the connexions are important items in regard to efficiency.

Paragraph 131.—It is cheaper to use iron oxide for coating the inside of pipes than galvanising.

Some other differences of practice might be pointed out, and some minor changes in construction and arrangements might be suggested in some few of the fittings recommended in the report, but none of these appear to the committee sufficiently important to call for particular comment, and, having regard to the scope and general objects of the report, the items referred to may be regarded as small matters for criticism in a report which, on the whole, deals so fairly and successfully with a large and difficult subject.

COMMENTS BY THE LANCET COMMISSIONERS ON THE FOREGOING NOTES.

Fig. 27.—Though the form of trap is not that in common use, nevertheless it has been proved to be a very effective one if used with the extra fall in the channel pipe as here shown. This fall, assisted by the contraction in channel and neck of trap, will undoubtedly clear same equally with the cascade action usually adopted.

Fig. 23, Paragraph 16.—This trap in cold service is no doubt somewhat exaggerated in the sketch ; of course its object is to prevent the circulation of any hot water from the cylinder through this pipe.

Paragraph 53.—The question of the hot water system has only been lightly touched upon. It was necessary to include it in the report so far as it related to the supply to baths &c. The addition of the by-pass for hot water up stairs in the early morning, thus avoiding the loss of time in heating all the water in the cylinder, would be a distinct improvement. The use of the stop-cock in the return certainly tends to the same end, but in severe frosty weather the circulation would be of advantage at night to prevent freezing in the flow or return services.

THE RELATIVE EFFICIENCY AND COST OF PLUMBERS' WORK.

INTRODUCTION.

Insanitary houses.—The undoubted fact that an immense number of insanitary houses of all classes exist demands careful consideration, first, to trace the reason; secondly, to ascertain what suggestions may be offered to remedy the evil. To assist in elucidation the enquiry has been extended among the professions and trades concerned in building operations and sanitary work.

The first reason.—The first and great reason lies in the prevailing indifference and consequent ignorance of all classes as to the various sanitary appliances by which they are surrounded.

The second reason is the bad work and cheap materials put in many houses by either unqualified or unscrupulous men, encouraged by a dangerous practice of putting such work up to the distorted competition of all who may choose to tender for it.

The third reason, and one which has perhaps as much influence as any, is undoubtedly the cost of rectifying sanitary work.

The first reason is slowly being corrected by the gradual education of the public through the greater interest taken in the subject by the medical profession. The power of the profession for good would be increased if a larger number of its members would follow the example of many and use their influence, so far as their opportunities will allow, to suggest that the sanitary condition of the patient's home should be ascertained in an obstetric or serious surgical case; but this is a matter of great delicacy. The second and third reasons form the subject of these enquiries.

The second reason raises a question that bristles with difficulties. It is one with regard to which only those intimately connected with the building interest can be qualified to suggest a satisfactory solution. How far their hands may be tied by the demands of the public is also a question. One thing is obvious, viz., that since the general adoption of the present contract system houses are not, as a rule, substantially finished, and the work is not of a satisfactory character. When this is the case in connexion with the sanitary arrangements the effect upon the public health must be prejudicial, and a grave responsibility rests upon all who are in any measure the guardians of the public in these matters to enquire into the question. As in sport, so in the more serious concerns of life, an observer may see many things not noticed by those engaged in the contest, and be able to form a better general opinion, though some things possibly appear anomalous which a more complete knowledge would explain. That really sound, good work is the exception, and not the rule, cannot be doubted. The question is: Is this the fault of the men engaged or the system followed?

The architect.—Perhaps there is no profession that calls for such varied qualifications as that of the architect—qualities that are not very commonly found in combination, the qualities of the artist, the scholar, and the engineer. An architect should have considerable scientific knowledge, be sympathetic, that he may readily assimilate the ideas of his clients, and have plenty of administrative capacity. To use such a man simply as a task-master to wrest and screw work out of the contractor, as is done by the present system, is nearly equal to the employment of Michael Angelo in moulding an image of snow.

System of contracting.—The interests of the architect and the builder, as far as possible, should be one, and not, as at present, too often opposed. If a stranger to the system were to take up an ordinary memorandum of agreement to be signed by the contractor for the execution of some small contract, say, for £1000, the first idea would be one of surprise that a man who required to be so much controlled as this contractor should be employed at all. The contractor is evidently branded as a dangerous rogue, who will try every dodge, even to taking refuge in the Bankruptcy Court, in order to avoid the proper execution of the work. Nay, more, he must sign away his birthright in many cases, and the architects or arbitrators ruling must have the force of a rule of Court. Against this sombre background the character of the architect, shown in a few light touches, stands out in pleasant relief. In the course of this inquiry it has become apparent that the contractors are themselves much to blame for their anomalous position. In their anxiety to obtain work it is undertaken at prices which would yield no profit if efficiently executed, irrespectively of possible errors in calculation. There is the chance that something may occur to upset the contract, and in that event they may continue the work upon better terms; or, again, they may have a quantity of machinery that would stand idle unless the work were obtained, in which case their loss would be still greater. If a contractor enters upon work upon either of these conditions the natural tendency is to seek relief by "scamping" it in some form. The effect that this has upon the architect is very marked.

Standard of prices, how formed.—Young architects seldom obtain their information upon practical details and prices through having spent a certain period in a builder's office; their knowledge of prices, as a rule, comes to them second-hand, thus: With every tender that is accepted the contractor's priced bill of quantities is left with the architect, who therefrom collects schedules of all the *lowest* prices at which work is undertaken. It is an average of these prices that forms the standard in general use, and to which an architect or surveyor would refer if called upon to check or arbitrate upon an account. Such prices cannot be taken as a proof of the real cost of work properly carried out. Mistakes may have been made, and in quoting prices that are too low in competition the mistakes that secure the contract must be all one way, so that work done at these prices may often have resulted in a loss. Thus it happens the contractor who makes the most mistakes is the one who chiefly influences the architect on the subject of prices. Architects and surveyors who have graduated in builders' offices, and whose knowledge of prices is consequently greatest, are unable to stem the current of a vicious system of contracting. There is an inducement for architects to be unduly led by the wants of their clients, especially in the case of leasehold property. Cutting prices are accepted, as it is felt that the work, so far as their client is concerned, is not required to be of a very lasting character, and the builder's shortcomings are treated leniently. The natural desire of the architect leads him to design buildings of good elevation. The client is possibly anxious for internal accommodation. The funds at disposal being limited, the builder is cut down to the lowest point, and the system offers him every encouragement to send in his estimate at the finest possible price. The master plumber particularly suffers from this, as contractors now either employ men directly, or occasionally sublet to the master plumber the work whilst absorbing a part of his profit.

The master plumber at one time could rely upon keeping a certain staff of picked men in constant employment. Now the contractor generally discharges the men directly they have completed the work in hand, and with this knowledge much of the interest the men formerly had in their work and their employer ceases. These remarks may at first sight appear irrelevant, but they are not really so: the tendency to cut down prices beyond a certain point leads to bad work. There is a great distinction between healthy and unhealthy competition.

Arbitration.—In all disputes that may arise over a contract an architect or surveyor is the arbitrator upon nearly all matters, including prices, for should these questions be taken into a court of law such details would not be dealt with by a judge, but be referred. It is, therefore, a matter of the greatest importance that the arbitrator should have his knowledge of values at first hand. The reference to a Court of Justice suggests a prominent example of the evil of the present contract system. Our new Law Courts are one of the most important buildings of the century, and a monument of artistic skill and industry. Upon this building the contractors spent some fifteen of the best years of their lives, and on its completion found their reward in the Bankruptcy Court—to the surprise, however, of no one. And why? Because the system allowed men to undertake the contract at about a quarter of a million of money below the next competitor. It is well known that great friction arose between the architect and builders, and there is little doubt that the worry entailed materially assisted in shortening the life of one of our most eminent architects and that of the builder also. Justice was, indeed, blind on this occasion.

Healthy and unhealthy competition.—The architect who is competent to arbitrate upon a builder's account is also competent to say whether an estimate is fair and reasonable without pitting a number of men one against another. Where the architect exercises this power the best work is done, the inducement to scamp work being removed, and that to carry out the work satisfactorily remains as there is a reasonable hope of future work being obtained from the same architect. If, on the other hand, the architect's client hopes to gain an advantage by the mistakes or necessities of others, the present system of competitive contracting affords him every prospect of attaining that end. Such competition, however, tends more towards a low price than efficiency, the contractor knowing that no matter how well he may execute the work it will not insure him other employment from the architect unless his tender is again the lowest. That the quality of the work suffers is well known, as board schools and other buildings have been erected with drains unconnected with the sewer or other omissions of an equally injurious character. It is, indeed, to the credit of the professional men who administer such a system that so large a leaven of latent honesty still remains undemoralised in the trade itself.

The third reason.—The cost of rectifying sanitary work is certainly a very complex matter both from the householder's point of view and also from that of the plumber, and demands a thorough examination. Everyone dreads sending for the plumber. Discomfort and expense are associated with his name. A frequent subject of complaint is the excessive charges for small repairs. Some little matter is found to require immediate attention, and word is sent to the plumber's shop for a man to go at once. In these cases the charges made often seem out of all proportion to the work done, but people do not think or do not know that plumbers are not kept at a shop ready to be sent out like message boys at a moment's notice. "The immediately-wanted plumber" has possibly to be fetched from some distant building, where he is at work in connexion with other men. His removal often requires a rearrangement of their occupation till he returns, which event may happen too late in the day to be of any advantage to his employer. As a rule, the "immediately-wanted plumber" is a dead loss to his master. Prejudice against the plumber often arises from the man technically known as the "three" branch hand. Though he assumes to be a plumber, painter, and gasfitter he is really an odd-jobber, who dabbles in many branches, and by his inefficiency brings discredit on the name of the plumber.

Attitude of public towards plumber.—The plumber's lot is not a happy one apart from the unhealthy and ofttimes unpleasant nature of his work. Being regarded as a nuisance, he is frequently treated with scant courtesy, and this has a tendency to induce a hostile feeling not at all conducive to the interest of the persons who employ him. His every statement is regarded with suspicion, and should he point out any important defect in the condition of the existing work or the system, from the manner his remarks are received one would suppose the fault referred to was of his creation. He will perhaps be told that everything has been satisfactory for years, and asked why it should be wrong now. It appears this position is largely due to the bad practice of the plumbers themselves. It frequently occurs through a faulty joint in the connexion of a watercloset to a soil-pipe, an insufficient supply of water, or perhaps from want of cleanliness that a watercloset, otherwise a good one, becomes a source of danger to a house. In such a case more discretion should be used than is frequently exercised by the plumber, who at once often recommends the complete removal of the whole apparatus. It would be better, after attention had been called to the weak points of the apparatus, to correct the defect and either make a sound joint, change the flushing tank for a better, or clean the basin and trap with spirits of salts. It is found that the objections frequently raised in reply to the suggestions of the plumber are that: "The present sanitary system is a craze. What is the use of making these alterations? If made, we shall be told in five years' time they are all obsolete." But the more frequent is: "We have lived in the house for so many years and have never had anything the matter before."

Remodelling sanitary work.—In any plan to remodel this kind of work such appliances should be specified as are least liable to get out of order through the carelessness of a workman or the neglect of those under whose care they are placed. Patchwork in connexion with drains and soil-pipes is a thing to be avoided, but the practice of pronouncing condemnation wholesale upon houses because they are not fitted with the very latest improvements is found too much in vogue.

The expert.—On the other hand, the position of the man who is called in to act as a sanitary expert is a difficult one. Take one illustration: The authorities at a large school asked an opinion before the return of the boys. The expert examined the house and prepared his report. He found many points that were certainly objectionable in theory, yet his tests did not afford the strongest evidence of the existence of any possibly dangerous condition, and he naturally hesitated to suggest fresh work of an expensive character. The house, so far as he could tell, might be lived in with safety. The question in such a case is, Who is to take the responsibility? The masters very properly will not. The plumber argues, Why should he? If the work be re-done throughout he can be certain of its soundness, whereas there might be some defect in the old work that he had not discovered. In the event of an illness occurring which might in any way be caused or increased by a defect in drainage, those who would be probably called in to inspect would then condemn the whole system and the man who had passed the work. It appears that in practice this influences every report made, though there is no lack of houses where condemnation is fully justified. Excuses for not doing work are frequently many and curious. One well-known law lord is reported to have said, when some glaring defects in the drains under the floors in his country house were pointed out and a suggestion made that they should be laid outside, "that he preferred having the drains inside, because in the event of any defect he became aware of it sooner!" In this case, no doubt, cost was the great difficulty. The question is, Is this great cost necessary?

Question of cost.—For new buildings the present sanitary system costs comparatively little more than that of twenty or thirty years ago; but in adapting the new system to old houses the case is different. In order to avoid having long lengths of soil- and waste-pipes inside the house fresh positions have to be found for water-closets and housemaids' closets, bathrooms, &c., which have to be constructed often at considerable expense. In fixing new soil-pipes in old buildings frequently many difficulties have to be overcome, such as cutting away or avoiding timbers or iron joists, hot-water pipes, &c., whilst the services of a bricklayer and carpenter are constantly wanted. But, after all has been said, it must be admitted that the charges made for sanitary work in many cases leave much to be desired. What is required is a standard of charges that will yield to the master plumber a fair remuneration for capital and time employed, or some properly qualified board to whom at a slight cost an appeal might be made by either side to act as arbitrators.

Plumber's profit and loss account.—Let us consider the question of what is a fair and legitimate charge for this kind of work. If we assume that our plumber's business has a turnover of £6000 per annum it will be rather in excess of the average, and quite as much as one man could possibly look after in detail, it being made up of small amounts. If less is done the working expenses will be higher in proportion to the amount turned over. If more is done the expenses will be increased considerably by the employment of efficient supervision, and also the entire establishment will have to be conducted upon a much larger scale. To turn over £6000 per annum he will require £2000 capital, of which he will have to sink about £500 in plant, which will consist of scaffolding, ladders, swing-boats, and tackle; benches, plumber's fires, metal-pots, plumber's irons, and sundry tools not found by the men; vices, a small forge and anvil, &c., pipe-cutting and screwing machines, moulds, &c.; office furniture, van, trap, horse, pony, and harness. About £250 are sunk in stock of material and small fittings constantly required. He will want all the balance of £1250 as working capital, and must be smart in getting in his accounts in order to make that do. His working expenses will be made up somewhat as follows:—Horse and van and driver; pony and trap, with boy, for his own use; clerk and office boy, stationery, &c.; rent, rates, taxes, insurance, water, and gas; yard man, to look up and send out material, &c.; premises account, including repairs and waste time of men occasionally kept on in slack times; interest on capital and discount; depreciation of plant; gratuities and sundries, and will amount to, say, £800 per annum, without any allowance for law charges, bad debts, errors of judgment in estimating, or the numberless unforeseen items constantly likely to arise. After a very careful examination of figures it would appear that any man who works at prices based upon those given in the following examples cannot (unless with a larger turnover than £6000) make more than some £300 a year, or 5 per cent. clear profit on the year's work. Unfortunately, in all cases the plumber cannot ensure even this modest profit legitimately, as in the case where work is done upon the present system under an architect. The practice is only to allow a gross profit upon actual cost of 10 per cent., but 10 per cent. (excepting in the case of large contracts, where it will pay) is a farce, as it cannot possibly cover the business working expenses. The condition of affairs is too often a duel between the architect and the contractor employed, the latter endeavouring to make a surreptitious profit by evading or "scamping" his work though the same is included in his contract or account. In the end the architect's client often pays a good deal more than 10 per cent. profit upon the work actually done, but the quality is inferior and every person connected with the transaction has been more or less demoralised.

Examples.—With a view to arrive at some definite conclusion three typical houses are dealt with in detail, the sanitary arrangements of which are supposed to require remodelling. The form of an ordinary report has been adopted, describing the condition of each house, while full notes are added for the guidance of the uninitiated and an estimate of cost is appended to each. The bills of quantities have been prepared in such a way that with a little care the approximate cost of any individual item may be arrived at. With this view most of the defects commonly found in houses have been concentrated in the examples given, whilst various forms of closets have been alluded to in order to give a choice. The work described is applicable to houses of any size, from a mansion to a cottage, though of course special treatment is often found necessary in factories, artisans' dwellings, and crowded courts ; but these scarcely come within the scope of the present inquiry.

Illustrations.—It has been thought desirable, for the guidance of the reader, to illustrate certain of the closets and other appliances ; these are, however, only put forward as types. It would obviously be unjust to the manufacturer of other forms of goods of equal merit if it were assumed that the particular ones indicated are those alone deserving attention.

The Examples.—The terrace houses shown are of the type to be found in London west end squares, and are generally built upon one or other of the plans shown in the following examples marked Nos. 1 and 2. The plans show that the houses have equal accommodation. For the purpose of illustration it is assumed that all the closets, baths, and other sanitary appliances require renewal.

Example No. 1.—The estimate which follows this example shows amounts to £618 3*s*. 10*d* , being greatly in excess of the cost of Example No. 2.

Example No 2 —Owing to the position of the closets, &c., being more favourable the cost amounts to £377 10*s*. 2*d*., the difference being £240 13*s* 8*d*. It would obviously be unfair then to draw any comparison of cost by simple enumeration of the number of closets, sinks, &c., which are the same in each case.

Example No. 3 shows the ground- and first-floor plans of a small suburban semi-detached villa. This allows us to keep the whole of the drains outside the house without difficulty, but here the question of expense assumes great importance. To suggest a similar treatment in all respects for the villa as proposed for the two previous houses would be impracticable. The estimate now shows the minimum cost for sound work. In this case the report is condensed, as it is assumed that the house is in an insanitary condition. It appears that the owners of this and a somewhat smaller class of property are often not in a position financially to place their houses in an efficient state of repair. If the house is not the property of the occupier he can by calling in the sanitary inspector compel the landlord to make good the defect, but he does so at the risk of receiving notice to quit.

General observations —"The jerry-builder"—that is to say, the man who without capital or conscience has covered large areas of London with houses of the worst possible description during the last thirty-five years—is, of course, responsible for the greatest number of the insanitary houses which exist. Inquiry has failed to elicit any additional information to that which is common knowledge, but unskilled labour, cheap fittings, light iron, or even zinc soil-pipes have been freely used by him. The next largest number of insanitary houses have been built during this period under the system of general contract and unhealthy competition. The good effect of the recent London County Council by-laws is only just about to be felt, but the testing of all new drains with water by the sanitary inspector, the regulations as to ventilation, and the quality or suitability of material used cannot but have a beneficial influence.

Inspection having been neglected, or carried out by incompetent sanitary inspectors, has greatly facilated the operations of the unscrupulous contractors. A development of the system of house to house inspection now adopted by some of the urban sanitary boards, especially in the case of the poorer class of houses, would be a distinct gain.

To sum up the results of the inquiry as to the excessive charges made by the plumber, enough has been said to show that the work of renewal, especially in the larger houses situated in a terrace, entails a vast amount of labour, not only in the actual plumbing and drain work, but in alterations and reconstruction, if the work is to be carried out in accordance with the conditions of modern sanitary knowledge. Many of the larger fittings are costly, whilst there are numbers of smaller ones required (mostly out of sight) which, though inexpensive, individually help to swell the general amount. It is also noticed that the material throughout is costly, and the plumber receives 1*d.* per hour more than other mechanics in the building trade—viz., 10½*d.* per hour. The plumber, moreover, requires assistance. These are matters of almost general notoriety, and they are taken advantage of by unprincipled men to make exorbitant charges. The details given will answer a twofold purpose, furnishing a useful approximate guide to those who have sanitary work to be done, and to a great extent, it is hoped, helping to check abuse. The plans and reports will also offer to those who have no time to read through a technical manual a brief summary of the system adopted at the present time by most of the leaders of the plumber's craft, and which have, at all events in all their larger features, the approval of the architectural profession and also that of medical officers of health.

THE TERRACE HOUSE.

REPORT AND SUGGESTIONS ON EXAMPLE NO. 1.

1. *Slate roof* front and back; small lead gutters; and flat in centre.

2. *Rain-water Pipe* **A** carries off water from the front gutter, and is of cast iron and trapped at bottom, where it enters the drain.

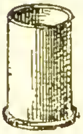
Note A.—The joints of this pipe being open, any smell coming from the drain is likely to be drawn into the house through the adjoining windows. Excepting in very wet weather, when the trap at the foot is constantly recharged, the gases in the drain air may possibly pass through this trap, owing to the water in same becoming saturated in consequence of the want of ventilation in the drain.

3. *Recommendation.*—This pipe should be cut off at the bottom from the drain and connected with an easy bend and short length of pipe into side inlet of new gully **FF**.

4. *Rain water Pipe* **B**, from the flat between the two roofs, is of lead, and is a continuation of the soil-pipe from the w.c.'s **J** and **K**, pars. 22 and 25, on the second and third floors. This pipe is of 4½ in. diameter, and is trapped at the foot (see Par. 35); it finishes level with the gutter and is badly placed as regards the skylight over the staircase.

5. *Recommendation.*—This pipe should be carried down the same course as before, either in cast iron or lead, the latter for choice, and continued under the basement floor in 4 in. stoneware drain-pipe to deliver over the gully **FF** in the front area. This drain must be laid on a 6 in. bed of concrete, and the lead down-pipe connected with it by a brass sleeve piece or thimble. (Fig. 1.) (Also see Par. 36.)

FIG. 1.



Thimble.

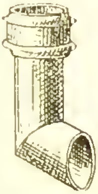
6. *Rain-water Pipe* **C**, at the back, is of cast iron and carried down outside until it reaches the soil-pipe of the ground-floor w.c. **M**, par. 29, to which it is connected; this also is trapped at the bottom.

Note B.—This pipe is open to the same objection as the one in front of the house; but, though the trap at the foot is kept charged by the water from the w.c., yet the drain emanations from the foul soil-pipe through which no current of air can pass are a constant source of danger to the back rooms.

7. *Recommendation.*—This pipe should be disconnected and made to discharge on the flat over the study after removal of old soil-pipe.

8. *Flat over the study.*—Rain-water pipe **D** delivers on the flat over the kitchen and is disconnected.

FIG. 2.



Rain-water shoe.

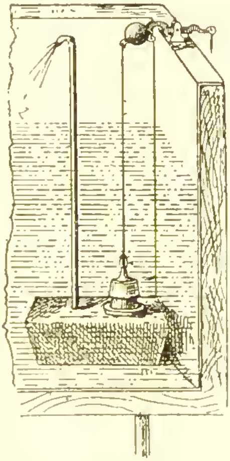
9. Rain-water pipe **E** from the lead flat over the kitchen is of cast iron and trapped at the bottom, and is immediately connected to the drain. (See par. 59.)

Note C.—In dry weather this pipe must be dangerous to those using the study and the morning room. (See Note A.)

10. *Recommendation.*—This pipe should be cut off from the drain and fitted with a shoe (Fig. 2) to discharge over the new flushing gully.

11. *Cisterns.*—There is a lead-lined cistern **F** in the roof holding 150 gallons; it supplies cold water to the housemaid's sink **Q** on the second floor and to the w.c.'s **J** and **K**, pars. 22 and 25, on the second and third floors, next the staircase. The waste from this cistern is trapped in itself and is connected with the adjacent soil and rain-water pipe **B**. A puncture has been made in the standing waste near the top in order to keep the trap recharged when the water is on from the main. This cistern is fitted with a service box for the supply of the top floor w.c. **J**, par. 22, has no lid, and has a large amount of dirt in it accumulated from the roof. It is presumed that the house has remained long unoccupied, otherwise the water company's regulations as to the overflow would scarcely have been evaded; but hundreds of similar cases exist where such regulations are not in force.

FIG. 3.



Cistern and service box.

Note D.—The connexion of this waste with the soil-pipe is quite unnecessary, and only offers an additional opportunity for the admission of bad air into the house. The puncture in the waste-pipe is a very uncertain precaution, as it depends entirely on the action of the ball valve. The practice of drawing the drinking water for bedrooms from the same cistern that supplies the w.c.'s is a great error, particularly as the third floor w.c. J is supplied by a service box (Fig. 3); the pipe from this to the closet is constantly charged with foul air from the latter. This is driven into the cistern from the air pipe in the service box by the descending water whenever the closet is used. As regards the second floor w.c. **K**, this, being a valve closet, is not open to the same objection, the valve being under the seat; the pipe between it and the cistern is constantly charged with water which rushes into the closet directly it is opened, affording but little opportunity for the passage of foul air back into the cistern.

12. *Recommendations.* — A dormer enclosure should be formed in the roof to hold the cisterns, as shown on plan, with a door on to the roof. There should be either stud and board or lath-and-plaster sides to keep out the dirt, and the sides and roof should be covered with 6 lb. lead. The warmth from the flues would assist to prevent the admission of frost. The dormer should be provided with louvres to admit fresh air, and with a wooden door to close the same in winter; it could be lighted from a skylight or sash, which should be made to open, as this would also light and ventilate the old w.c. **J**, which will now be used for housemaid's sink **Q**. This cistern **F** can be used exclusively for the supply of the w.c.'s, and must be moved to a fresh position for this purpose. A 1½ in. lead overflow pipe from this cistern should be provided to deliver into the external gutter. A 1½ in. stout lead service pipe should be carried down as far as the second floor, fitted immediately under the cistern with a screw-down stopcock. The cistern should be provided and fitted with a wooden lid.

13. *The Cistern* **G** *on Flat* is of slate and holds about 300 gallons. This cistern furnishes the supply for the hot water throughout the house as well as cold water for the bath and w.c. **L** adjoining the bedroom; the overflow discharges on the flat.

Note E.—This is open to the same objection as the last, as it supplies the hot water for kitchen use as well as the w.c.; it is badly placed in event of severe frosts.

14. *Recommendations.*—Provide and fix a new ⅛th plate galvanised iron cistern **G** to hold 300 gallons in the new room provided and carry a 1½ in. overflow pipe on to the flat, and clear away old slate cistern.

15. This cistern **G** is to supply the hot-water system and the cold draw-off to the bath, and all sinks with the exception of the one in the scullery.

16. Connect a 1¼ in. lead pipe, with a 1¼ in. screw-down stopcock fixed in the same close to the cistern, and continue down to the basement with a 1 in. branch formed into a trap under the cylinder **H** in kitchen

to prevent the return of the hot water. This stopcock must be protected or the key should be kept by some responsible person that this cock may not be tampered with. (See illustration to Par. 53.) Bring in a ¾ in. branch from this pipe to supply the housemaid's sink fitted with a screw-down high-pressure bibcock. Provide and fix a 1½ in. overflow pipe from this cistern to deliver separately on to the lead flat.

17. *Cistern* **H.** — There is a lead-lined cistern in the cupboard under the ground-floor w.c. **M,** which supplies the w.c. **N** in the scullery, the scullery sink **R,** the copper, and the sink **S** in the servants' hall. The waste of this cistern is trapped in itself, and is connected with the soil-pipe of the w.c. **M.**

Note F.—This is a most dangerous position for a cistern—viz., under a closet. As an example, one so placed where the lead trap of the closet protruded through the ceiling over the cistern was stopped up. A member of the household endeavoured to unstop it by means of a poker from the closet above. At last a hole was made in the trap, and finally its contents disappeared into the cistern below, as was discovered subsequently.

18. *Recommendations.*—This cistern **H** should be replaced by a 100 gallon galvanised iron tank, and should be fixed in the new larder to supply the scullery sink by an inch lead pipe fitted with a screw-down horizontal bibcock, and the overflow pipe should be carried into back area.

19. *Cistern* **I.**—There is an old cast-lead cistern **I** at the end of the front area which supplies the w.c. **O** in the vault, the pantry sink **T,** and the one **U** in the housekeeper's room; the overflow of this cistern is disconnected.

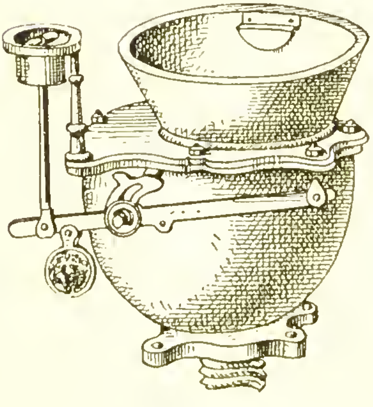
20. *Recommendation.*—This cistern must not be allowed to supply the sinks as well as the closet, and it is too large and too low to supply the latter. The value of the old lead will pay for a new 50 gallon galvanised wrought-iron tank fixed at a higher level for the supply of the w.c., which cistern must be covered round with hair felt and a wood casing to guard against frost.

21. *Main supply.*—Remove the present large lead service pipes to the several cisterns and carry up a ¾ in. lead service with necessary branches for the supply of the cisterns placed in new positions. Provide and fix, as required by the water company, a ¾ in. screw-down high-pressure valve in the area, and also an equilibrium ball valve to each cistern. Encase all pipes exposed in the area cellar and in roof with hair felt, bound with copper wire.

Note G.—To find a suitable position for the cisterns is a point frequently neglected. The place selected should be fairly light, warm, accessible, and well ventilated, also as free from dust as possible, and all should be provided with a wood cover. Neglect of this precaution is a reason why cisterns are sometimes found to hold such undesirable details as the remains of lost domestic pets, rabbits, guinea-pigs, or rats, mice, and birds. Again, lead should never be used to line cisterns in which potable water is to be stored, even when the pipes that lead to the sinks may safely be of lead. A piece of bright lead suspended in water or exposed to the air is quickly tarnished from the formation of a film primarily of lead oxyhydrate. This oxide is soluble in water to a limited extent. Fortunately London waters are hard, and mostly contain considerable quantities of sulphate and carbonate of lime, and form a protective coating largely consisting of carbonate of lead, which is insoluble in water unless it contains an excess of CO_2. But slight traces of lead may sometimes be found in waters that have been stored in lead-lined tanks. The action of this metal in minute doses upon the system is so gradual that the mischief is often referred to other causes, and for this reason its use should be abandoned. Where an old lead cistern is retained, it should be coated with a cement that will prevent the contact of the water. Galvanised iron tanks are now in general use in London, where the water is hard, but they are not so suitable for the storage of a very soft water (especially rain water collected in the neighbourhood of large towns). In this case the zinc used in galvanising the iron is decomposed, and floats on the top of the water. This action ceases, however, after a time. Slate is an excellent material to use for cisterns, provided the joints are not cemented with red lead (as is usually the case). Indiarubber packing may, with advantage, be used for this purpose.

22. *Water closets.*—The third floor W.C. **J** on plan is unprovided with any means of light or ventilation, except on to the staircase. This is a pan closet, supplied by means of a ¾ in. lead pipe and service-box in the cistern in the roof (see Par. 11). There is a lead safe under the closet, with a waste from same carried into the side of the closet trap. There is also a D trap, par. 23, under the closet, with a hole in the top caused by a carelessly driven floor brad.

FIG. 4.



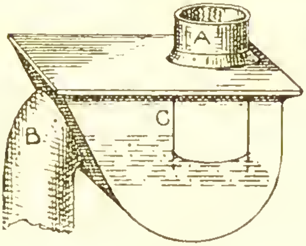
Pan-closet.

Note H.—Though the objections to the pan-closet are so well known and the future use of this closet is prohibited by the laws of the London County Council, thousands of them are still in use. The accompanying illustration (Fig. 4) will assist to give a clear idea of its construction. The soil is received into a small copper container or pan (which gives its name to the closet), and into which the basin dips. This is worked by a lever and axle in connexion with the handle; the contents are thus thrown into the iron container in its passage to the trap. The condition of the iron container after a few months' use can be better imagined than described, and the bad air from the container finds free access to the house through the hole in which the axis works.

It is one more unnecessary risk for the waste of the safe to enter the closet trap.

23. *The D-Trap* (Fig. 5).—As this is a kind of trap commonly met with, though its further use is prohibited by the by-laws of the London County Council and urban authorities generally, yet a few words in reference to it may not be out of place. 1. It does not readily permit the discharge of the whole of its solid contents every time the closet is used, whilst its capacity is large. 2. From its shape it offers a large surface for the accumulation of fur (urates, &c.), which soon impregnates the water and renders it very offensive; this large surface is subjected also to corrosion from the action of gases, which generally attack the dip-pipe A above the water line. A is the inlet or dip immediately connected with the w.c. apparatus, through which the soil passes into the trap; B the outlet or connexion between the trap, and the soil-pipe should be fixed close to the top of the trap as the lower edge of this pipe regulates the height of the water line. The bottom of A is made to dip into the water about an inch. It will at once be apparent that any gas that rises up B is confined in the space C, unless under pressure it can force its way through the water that seals the bottom of A. The only thing to recommend this trap was its large water seal when properly made and the resistance to syphonage offered by the confined air in C.

FIG. 5.



24. *Recommendations.*—The position of this closet, marked J on the plan, must be altered to one against an outer wall (see amended plan), provided with as large a window as can conveniently be got to light and ventilate the same. The wood partitions that form the closet must be plastered down to the floor on each side before the skirtings are fixed. A good closet to use here would be an improved flushing rim short hopper basin supported by lead cone, fitted with an earthenware slop top, one with a lead pedestal and trap contrived as shown. (Fig. 6.) The slop top is not illustrated. As this can be used as a housemaid's slop sink, the floor under this closet should be covered with lead, with the front edge

turned over a wood fillet and a 1¼ in. waste-pipe carried through the external wall and the end of the same fitted with a draught check. A 3 gallon syphon (wherever possible), silent, water-waste preventer may be fixed to supply the basin with water, with a 1¼ in. lead service to the arm of the basin fixed with cast lead tacks. This small cistern should be fixed as high above the closet as convenient, and is to be itself supplied by a small ½ in. branch off the 1½ in. down-pipe from cistern **F**, fitted with a ½-in. screw-down stopcock near the ball valve, for use in case of repairs. The ¾ in. overflow should be carried through the external wall. If a closet is used with an independent trap, it may either be a drawn-lead P-trap (Fig. 7) or an anti-D-trap (Fig. 8). The latter is somewhat less liable to syphonage, but as all closet traps must be fitted with anti-syphonage pipes (see illustration to Note O, Fig. 17), this point need not be considered overmuch. A 3½ in. branch soil-pipe

FIG. 6.

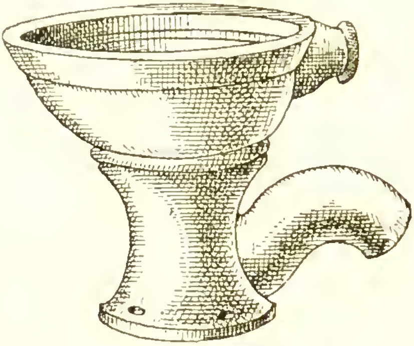
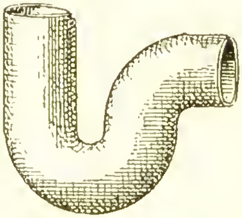
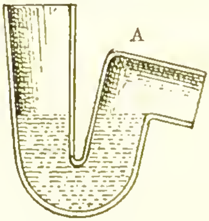


FIG. 7.



Syphon Trap.

FIG. 8.



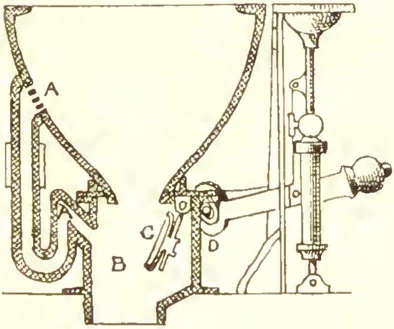
Anti-D-trap.

weighing 10 lb. to the foot, soldered to the trap, is taken through the wall and connected with the new external soil-pipe. The anti-D-trap has the advantage of the square outlet, and the air-cushion formed by the corner A, which renders it somewhat less liable to syphonage than the syphon trap. If a syphon trap is used it must be of drawn lead. The cast traps frequently have a rough internal surface where the moulds meet in the casting, which forms an obstruction to the passage of soil and paper. They are also apt to be of an unequal thickness. The lead anti-D-traps cannot be made of drawn pipe, but are cast, and for this reason they should be carefully tested before use. It is only fair, however, to state that some firms make cast traps that are perfectly smooth inside.

25. *Closet* **K**, *Second Floor*, is situated like the last, as it is without any direct communication with the outer air. It is an old valve closet with a fan spreader instead of flushing rim, with overflow facing valve in valve box, which latter is not ventilated. It is supplied from cistern **F**, par. 11, by a ¾ in. lead service with a ¾ in. valve and brass regulator. There is a lead safe under it, with the waste trapped in itself and connected with the soil-pipe. This trap is kept charged by means of a small weeping pipe which is brought into action each time the closet is used. There is a D-trap under the closet, as in closet **J**.

Note I.—The general principle upon which this closet is constructed is still admitted to be one of the best, but the improvement made in recent years by the substitution of the flushing rim for the fan, and the reverse positions of the overflow behind instead of in front of the valve, greatly adds to the sanitary value of the closet. This will be best seen by reference to the accompanying illustration. (Fig. 9.) It is obvious that if the overflow A enters the valve box B in front of the

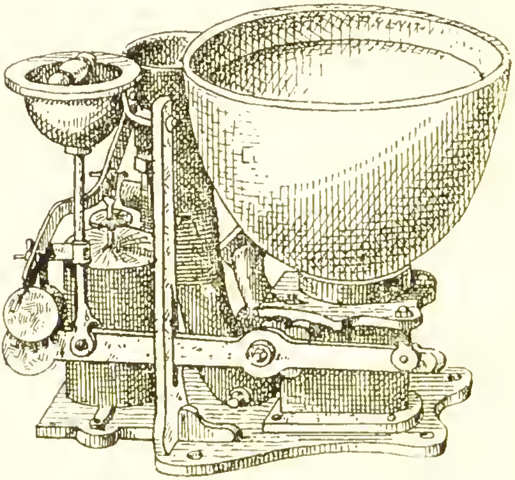
FIG. 9.



valve C, when the valve is opened some of the contents of the basin must be thrown into the pipe A where it enters B, but if it enters at D behind the valve this cannot happen. The flushing rim not only gives a larger water-supply, but acts with almost equal force on every part of the basin, which the old-fashioned fan-flush does not do.—When slops are thrown down the upper closet **J** some of the water is syphoned out of the D-trap under this (**K**) closet, and all the water is syphoned out of the trap in the waste of the lead safe, so that until **K** is used again and this trap recharged the foul air from the soil-pipe can freely enter the house through this waste-pipe.

26. *Recommendations.*—Form a closet over the well of the staircase, with the stairs and landing to reach the same as shown on the plan, with external window with top and bottom sashes to open. Lay throughout the closet a tiled floor, and, should the funds permit, tile the walls also. If expense is of paramount importance, this closet may be properly cleaned and re-fixed, and a 1¼ in. ventilating pipe fixed in the valve-box, and carried through the external wall. The proper course would be to use a more effective modern closet. If a valve (Fig. 10) (also see Note J) it should be of best make with a flushing rim, with separate supply to

Fig. 10.



the overflow pipe, and the valve-box should be ventilated by a 1¼ in. pipe carried through the external wall and cut short off outside. A 1¼ in. valve and regulator should be fixed under the seat. The supply to the basin should be by a 1¼ in. lead pipe connected with the 1½ in. down service from cistern **F**, par. **11**, in which pipe, under the w.c. seat, a 1¼ in. screw-down stopcock is to be fitted. Provide a lead trap as described for **J** closet, and carry the branch 3½ in. pipe into the same external soil-pipe as from closet **J**. Provide and fix a 5 lb. lead safe with 1½ inch waste-pipe through the external wall fitted with brass flap valve. The old mahogany seat and riser may be used again as far as possible, but the seat must be fitted and hung with brass hinges to afford ready access to the closet. The whole of the wood and plaster work under the seat and the under side of the seat itself also must be painted with three coats of oxide of zinc paint to prevent absorption and discolouration. Lay on the water from the new 1½ in. down service and provide the trap and branch to the external soil-pipe as described for closet **J**.

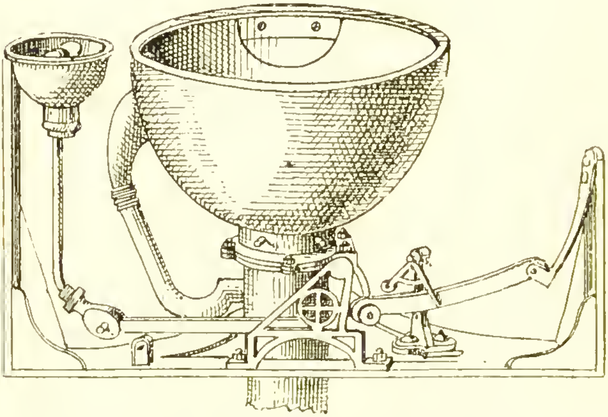
Note J.—The valve closets, though some object to them on account of their rather complicated construction, are, when of good make, the best closet for use in connexion with a lead soil-pipe. The two principal troubles that occur with them are (1) the irregular action of the regulator, which at times lets in either too much or too little water after the handle has been let go, and (2) the escape of the water that should remain in the basin on account of paper or slop refuse which gets between the valve and the seating and prevents its proper action. The first trouble generally arises through an accumulation of dirt and stale oil in the regulator, which, by the way, should always, if of the telescope pattern, be charged with glycerine, which congeals at a much lower temperature than oil. The bellows regulators are the most reliable in their action. The second difficulty is more often the result of carelessness in use. If the handle were held till the contents of the basin have been all flushed away it would not occur. The advantages of the valve closet are, first of all, that the weakest joint—viz., the connexion with the trap—is made on the right side, or rather the house side, of the trap. The closet holds a large quantity of water in the basin, which forms a second trap. The outlet is in the bottom of the basin, and there is never any difficulty in emptying it completely of its contents. In selecting a closet see that it complies with the following conditions: 1. It should have a white basin with a good flushing rim. 2. It should have a lead valve box and a ventilating pipe from the same. 3. The overflow should enter the valve box behind the valve and should have a separate service pipe to the charge trap, or no overflow, but a lip in the pan of the closet to the overflow into the safe, in which case proper provision must be made for same; but this last arrangement is not so desirable. 4. The handle should have a parallel action and should work so as to open and close the valve easily and without jerking.

27. *W.C.* **L**, *next to Front Bedroom.*—This is an old Bramah pattern closet (Fig. 11), supplied by means of a service box and a ¾ in. down pipe from the slate cistern on the flat. There is a lead safe under, with overflow into a small independent D-trap, the outgo of which is connected with the soil-pipe. The closet is fitted with a D-trap; the top of this trap is much eaten away and corroded.

Note K.—The old Bramah w.c. was the pioneer of the valve closet. The valve is fixed in the cistern, and this is worked by means of a wire and cranks. When the handle is raised some time elapses before the water from the cistern reaches the basin, according to the distance it has to travel; it has no flushing rim and has been entirely superseded by the valve closet. (See also Notes D and I and illustrations to same.)

28. *Recommendations.*—Owing to the position of this closet in the centre of the house, and the difficulty of light and ventilation, it must be done away with entirely. In this particular case the adoption of this course presents no difficulty, as there is another on the same floor.

FIG. 11.



29. *Ground Floor W.C.* **M.**—This is a side wash-out closet, with basin and trap in one piece of earthenware, supplied by means of a small flushing cistern, which obtains its water from cistern **F**. There is no safe. The internal fittings of the supply cistern are all of iron. The cistern is very noisy when used.

Note L.—It may be taken as a rule that no closet should be used with an earthenware trap connected to a metal pipe, because the joint is made on the sewer side of the trap, and, although many excellent devices have been brought out and largely used, the risk attendant upon a fracture is one better avoided.

The wash-out closets, with either back, front, or side outlets (Fig. 12), rapidly fur up round the outfall into the trap; this fur soon impedes the passage of soil and produces an offensive smell. The trap is seldom thoroughly cleared, as the force of the water is expended or broken in the basin. The outlet of any closet should be in the bottom, so that the whole force of the water acts immediately so as to clear the trap.

30. *Recommendations.*—This closet **M** must be done away with also, and the closet should be formed in an altered position, as shown on plan, in order to place the soil-pipe outside and gain better ventilation; it should have a tile floor throughout. A pedestal closet may be used here, supplied by a flushing cistern with copper fittings and silent valve, as described for w.c. **J**, with syphon trap and short branch into the external soil-pipe. The supply for this closet would be by an inch branch from the continuation of the 1½ in. service to the closet on the second-floor landing to the basement. Use a flushing cistern as described for Closet **J**, but

Fig. 12.

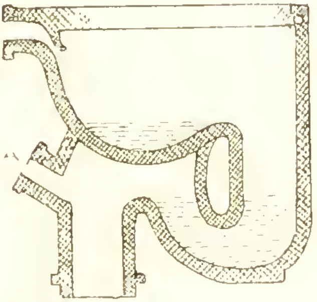
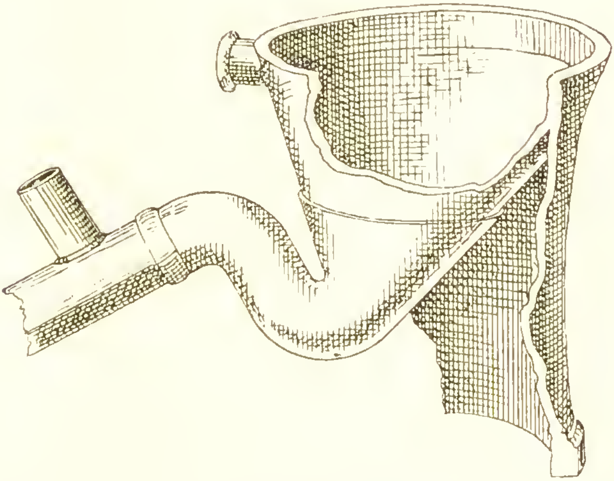
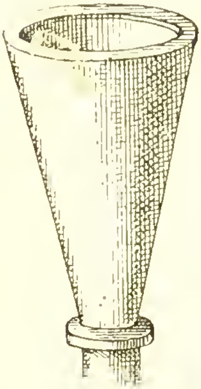


Fig. 13.



with plated fittings to pull. There are several excellent pedestal closets to be had. The trap must be of 8 lb. lead, as before stated.

Fig. 14.



31. *Basement W.C.* **N** *in Scullery.*—The position of this closet is highly objectionable. It is intended to be ventilated by a skylight, the cord and quadrant of which are broken. The closet is one known as a hopper (Fig. 14), not with a flushing rim, and has an earthenware trap under the same. It is supplied from cistern **H** in the cupboard under the ground-floor w.c. by means of a cottage valve under the seat. Owing to the poor supply of water through this valve this closet is in a very dirty condition.

Note M.—No closet should ever be fixed in a room that communicates directly with another room where food is either prepared or stored. The closet must always be divided from such room by an enclosed lobby, which, as well as the closet, must have direct communication with the external air by either door or window.—A hopper closet with a fan spreader is invariably in a filthy condition, and in such a position as indicated on the plan would be a constant source of danger to health.

32. *Recommendations.*—Remove the sink **R** and closet **N**; cut away the lead flat over, and form an open area (as shown on amended plan) lined with white glazed tiles. Cut a doorway into the kitchen and build walls to form a new larder and scullery, both with glass partitions, to look into the new area. Alter partition walls on opposite end of scullery to enclose new sink, and provide for and fix window (to open) looking into middle area, as shown on corrected plan. Provide a door from the area into the larder for access from the kitchen; render the walls of the larder in cement and line with white glazed tiles, and fix slate shelves in same. Provide and fix in the centre of the lead flat over the kitchen a new lantern light and make good the flat after the removal of the old skylight. Build a brick partition across the end of the middle area and form a new w.c. (**N**), with either slate, zinc, or lead roof; form a window in the same to open, and provide a door which will show a 3 inch space at both top and bottom of the opening. Cement the walls throughout, and finish the floor with either stone, cement, brick, or tile. Provide and fix in same a white earthenware pedestal closet and trap, with basin with flushing rim

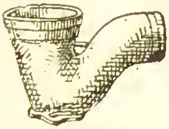
and provide and fix a painted seat hung to lift up. Carry 2 in. anti-syphonage into new anti-syphonage-pipe from w.c. **M** connected with branch arm of closet **N**, with a brass sleeve piece (Fig. 1). The supply is by means of a 3 gallon flushing syphon-action water-waste preventer, with a $1\frac{1}{4}$ in. supply pipe to the basin fixed six feet above the floor of the closet, and this cistern is to be supplied by a $\frac{1}{2}$ in. branch from the service to the ground-floor w.c. **M**, in which a screw-down stopcock is to be fixed.

33. *W.C.* **O** on the plan is of similar construction to the last one, but is supplied by a valve fixed in cistern **J**, par. 19, in the area, and connected with wires and cranks; the small head of water this gives is quite inadequate to the requirements of the closet. (See note on closet **N**, par. 31, *re* hopper closet.)

34. *Recommendation.*—A half-brick enclosure is to be formed in the vault and fitted with a door, cut short some 3 in. both top and bottom. If possible, place this enclosure at the side of the vault next the area with a 12 in. by 12 in. hole into same fitted with an open iron grating for ventilation; provide and fix in same a closet the same as described for **N**, but with an additional cistern to hold about twenty-five gallons, fixed as high as possible under the arch of the front door-steps and landing, to supply the flushing cistern. This cistern will be charged direct from the main.

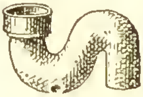
35. *Soil-pipes.*—They are all of $4\frac{1}{2}$ in. seamed lead and are much furred; each pipe is trapped at the foot by an earthenware S-trap. (Fig. 16.) The pipe **B** from closet **J** is also a rain-water pipe, and is continued up to the roof in lead throughout, but in the smaller diameter of $3\frac{1}{2}$ in. The soil-pipe **P** from closet **L** is unventilated and is perforated on the top of the short horizontal length next trap. It passes down into the drain in the wine cellar in the same casing with the hot-water pipes, the heat from which and from the hot water

FIG. 15.



P TRAP

FIG. 16.



S-trap.

from bath (see par. 49) has expanded and contracted the soft lead until at the joints the lead has torn away from the harder metal and produced a fracture which extends half round the pipe. Again, where this pipe passes through the brick wall it is much decayed owing to its contact with lime or cement used in the wall. All lead pipes should be covered with tarred felt when in contact with cement or lime. The soil-pipe from the closet **M** is carried up through the lead flat over, where it is connected with the iron rain-water pipe **C** from the main roof.

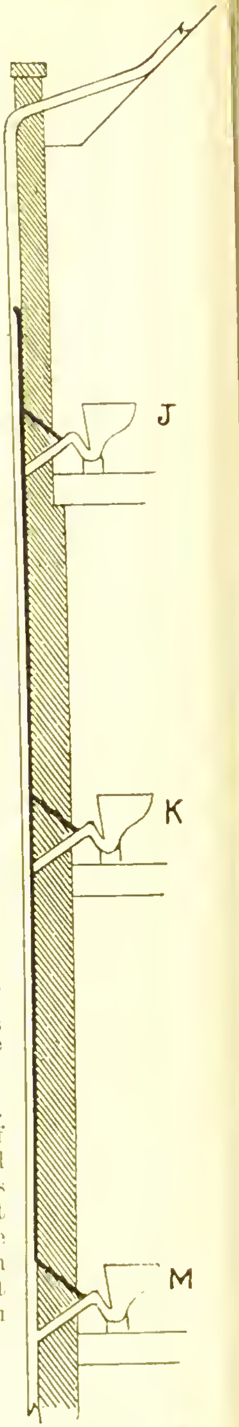
Note N.—Except in cases where long lengths of soil-pipe have to be carried horizontally it is better that the diameter should not exceed 3½ in. This size pipe never becomes foul like one of a larger size, for the reason that a given quantity of water exerts a much greater mechanical force upon the sides of the smaller pipe than is the case in one of larger size. Its velocity and carrying power are much greater in the contracted space than is the case in the larger pipe, where it frequently happens that portions of soil adhere to the sides, while the water spreads to and runs off in other parts of the pipe.

The corrosion noticed in soil-pipe **P**, par. 27, is caused by the entire absence of ventilation, and the consequent non-removal of soil gases, as ammonia, carbonic acid, sulphuretted hydrogen, &c. The gases generated in the foul soil-pipe act more readily upon the upper part of the horizontal pipe and D-trap (which is never touched by water) than upon any other part of the pipe. The lead gradually crumbles away on the inside until it becomes as thin as a piece of paper, when small powdery excrescences appear upon the outside surface, which, upon being rubbed off, show a perforation. Seamed soil-pipes such as these often rapidly decay in much the same way at the side of the seam; this is no doubt aided by a galvanic action set up between the soft lead and the hard tin of the joint.

As already explained, serious damage to this pipe was caused by the proximity of the hot-water pipes. Had these and the soil-pipe been coated separately with asbestos or some other good non-conductor, it is more than probable that the soil pipe would not have been damaged.

36. *Recommendations.*—A new 3½ in. 10 lb. lead soil-pipe **B B** should be fixed at the back of the house, to which in its course will be connected the branches from closets **J** and **K** and **M**. Its upper end should be carried up over the parapet to about 2 ft. above the ridge; this pipe must be protected by a wood casing where it crosses from the parapet to the roof, and it must be fitted at the top with a copper-wire guard. Each length

FIG. 17.



Anti-syphonage Pipe.

must be provided with six cast-lead tacks, weighing about 7 lb., each soldered on the soil-pipe in pairs at equal distances throughout. The bottom of the pipe must be fitted with a stout brass thimble, soldered to same for connexion with the iron branch to manhole. The use of this thimble is twofold. It prevents the compression of the lead after the joint has been made with the drain, which would fracture the joint, and it also prevents contact of the cement used in the joint with the lead, and subsequent destruction of the lead from this cause. When the drain is of iron it is impossible to make the connexion without a thimble. (See illustration par. 5.)

37. A strong lead 2 in. anti-syphonage pipe must be carried up at the side of the soil-pipe from the branch soil-pipe, just above the trap of the bottom closet **M**, and the same may be connected into the soil-pipe a few feet above the branch of the anti-syphonage pipe from the closet **J.** Closet **K** must also be fitted with a similar branch pipe, as shown on sketch.

Note O.—The action of the anti-syphonage pipe is as follows. We will suppose a stack of soil-pipes Fig. 17) say 50 ft. or 60 ft. high, with three closets connected into it one above the other (of course, should the soil-pipe be unventilated or badly ventilated at the top the chances of syphonage taking place will be greatly increased). A pail full of house slops is thrown down J, which completely fills up the aperture of the soil-pipe. As it rushes down a vacuum is created behind it, while the air in the pipe in front is violently compressed, with the result that the water in traps K and M is greatly agitated with compressed air (which may pass through the trap) in the first instance, and then very probably be sucked out by the vacuum created after the falling water has passed the traps, whilst J stands a chance of being sucked dry also. With the anti-syphonage pipe this cannot take place, as the compressed air will find relief up this pipe before the water has passed each closet and also draw air down same afterwards instead of first emptying the closet traps to draw the required air from the room.

38. *Sink* **Q**.—There is a small lead-lined sink under the stairs on the second-floor landing, the **1** in. waste-pipe from which is connected into the side of the D trap of w.c. **K.** The cold supply is from cistern **F**, par. **11.**

Note P.—This is a very bad position for a housemaid's closet. Any place in which slop-pails, &c. are kept should have plenty of light and ventilation, all of which are here absent.

Lead is by no means the cleanest material with which to line a sink where water-bottles for use in the bedrooms are to be filled.

The connexion of the waste with the D-trap of the closet is a grave error; no waste of either sink, bath, or lavatory should ever have any direct communication with the drain.

39. *Recommendation.*—This sink must be done away with.

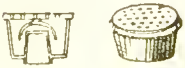
40. *Sinks.*—A fireclay enamelled sink (**Q**, third-floor) is to be fixed in the housemaid's closet under the new cistern room, formerly w.c. **J**, with a 1½ in. strong lead waste-pipe, and a cast-lead syphon trap fitted with a brass cleansing screw must be fixed in the waste immediately under the sink. This waste-pipe is to be carried down to the basement at the side of rain-water pipe **B**, par. 5, fitted at the bottom with a brass thimble, and continued in a strong iron pipe with caulked lead joints under the floor of the passage and pantry into the front area, where it delivers over a gulley. The upper end of this pipe is to be carried up in the cistern room and through the lead flat over, where it finishes about 12 in. above the flat, the end being fitted with a copper-wire cover. The trap must be provided with an anti-syphonage pipe connected with the ventilating pipe. Hot and cold screw-down handed bib-taps must be provided. The cold supply comes from cistern **G**, par. 15. A small ½ in. branch must be connected with the rising main with a screw-down, high-pressure bibcock on same. (See par. 123.) The whole of the floor of this closet should be covered with 7 lb. lead close, copper-nailed round and across.

41. *Sink* **R** *(Scullery).*—This is badly lighted from a fixed skylight. It is a stone sink with a movable brass bell trap (Fig. 18) connected by an upright length of stoneware pipe to the drain. The cold supply is taken from cistern **H**, par. 17, through a ¾ in. lead pipe, and the hot supply from the bath circulation, which is supplied from the slate cistern **G**, par. 13.

Note Q.—Its position next to the w.c. and want of light and ventilation at once condemn it. Stone sinks are absorbent to a certain extent and are therefore more difficult to keep clean than those made of enamelled earthenware.

The old bell-traps are happily almost extinct—as very few firms make them—but they may be met with occasionally. The top, or bell, is movable and is seldom in its place. The position it occupies is not, however, of much moment, as it generally traps ⅛ in. into about 2 oz. of water. The direct connexion with drains is of course an evil—aggravated in this case by the use of an upright drain pipe above the ground, which would be additionally liable to fracture of either the pipe or the cement joint.

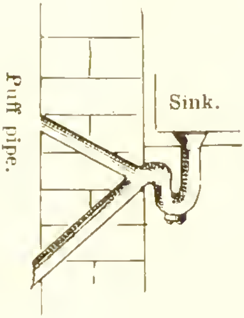
FIG. 18.



42. *Recommendations.* — The alterations shown on the amended plan and described under w.c. **N**, par. 32, will

give abundant light and air to this scullery. After the removal of the old sink and all connexions, including the hot-water supply, fix a glazed stoneware sink **R** with a 2 in. stout lead waste-pipe, fitted with a lead syphon trap, which with cleansing cap and screw should be carried through the external wall to discharge into the flushing gully. (See Drains, Note z i.) A 1½ in. anti-syphonage or puff pipe (Fig. 19) is to be connected into the waste just by the outgo of the trap, carried through the external wall, and cut short off with a + copper wire fixed in the end. Provide and fix screw-down bibcocks to hot and cold supply, and continue branch from former to supply sink in new position. (For the latter see cistern **H,** par. 18.) Provide a draining board, fixed under the plate-rack, to carry the water from same into the sink, cover with pewter.

FIG. 19.



43. *Sink* **S** (*Servants' Hall*).—This is a lead-lined sink, much worn and patched. The 1 in. waste-pipe passes into a 6 in. D-trap, and is then connected into the drain. It is supplied by cistern **H,** par. 17, with cold water and hot water from the bath system.

Note R.—The use of the D-trap under this sink, although less objectionable than when used in the larger size under the closet, must be condemned. It is not only dirty in itself, but it retains an unnecessary quantity of dirty water.

44. *Recommendations.*—A deep glazed stoneware sink should be fixed here, fitted with a brass plug waste; the waste-pipe to be 1¼ in., strong lead, with proper syphon-trap under the sink and brass cleansing cap in same. The waste should be carried through the external wall to deliver over the new gully **Y.** A short 1 in. anti-syphonage pipe should be fixed just above the trap and brought through the external wall with + copper wires fixed in the end of the pipe. Lay on a ¾ in. branch stout lead pipe from the 1¼ in. down service from cistern **G,** par. 15, fitted with screw-down, high-pressure, horizontal bibcock, and provide a new cock of similar pattern for the hot-water service.

45. *Sink* **T** (*Pantry*).—This is a lead-lined sink, as the last, but the cold supply comes from the lead cistern **I** in the area.

Note S.—It will be more convenient to have this sink, which is used principally to wash glass at, lined with lead, and the draining board covered with pewter. The sink should be made with a division across the centre, as a double one.

46. *Recommendations.*—Remove the old sink and waste, &c. Provide a double sink lined with 6 lb. lead sides and 8 lb. bottom, fixed in the window recess. Each sink is to be treated in all respects as sink **S**, with the addition of covering the board under the bottle rack with pewter.

47. *Sink* **U** (*Housekeeper's Room*).—This, a small lead-lined sink fitted into the window recess waste, has no trap and is disconnected over an external gully. Supplied from cistern **I**, par. 19. No hot supply.

Note T.—It is objectionable to have a sink waste, even if disconnected from the drain, without a trap. The smell from the accumulation of stale soap in the pipe is drawn into the room accompanied by effluvia that may arise from the dirty water in the gully. A glazed fireclay sink is much better and cleaner for this room. In the case of the servants' hall, the dishes, &c., used for the servants' dinner are washed there, and a deep sink is necessary for the purpose, whilst in the scullery large tubs are chiefly used and a deep sink would be inconvenient

48. *Recommendations.*—Provide a small enamelled fireclay sink with 1¼ in. waste-pipe, carried into **HH**, properly trapped and ventilated as the last. Bring a ¾ in. branch lead pipe from the 1¼ in. down service from cistern **G**, par. 15, and provide a ¾ in. screw-down horizontal bibcock as before.

49. *Bath.*—The room in which this bath **V** is placed is very dark; there is no window, and only a borrowed light from the fanlight over the door on to the landing. This is a zinc painted bath enclosed with a mahogany framed casing and top. The hot and cold supplies are brought into a box under the waste in the bottom of the bath, and are, with the waste fitted with ground-in full-way plug-cocks, worked by long iron keys and cranked handles fixed at the head of the bath. There is a lead safe under the bath with a sunk well and small lead D-trap under. The waste from this well is carried into the soil-pipe **P** of closet **L**, par. 35. The waste and overflow of the bath are carried from the box in the bottom and deliver over the top of the trap in the well of the safe. The cold supply is from cistern **G**, par. 13.

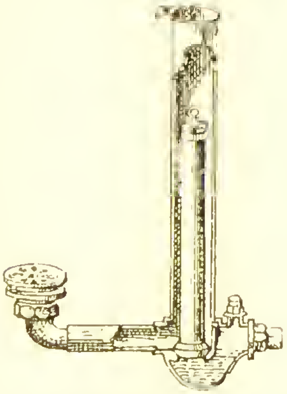
In large establishments, where possible, a second bath for servants' use should always be specified.

Note U.—To allow the hot and cold water to enter up the waste into the bath is a very bad arrangement, and a breach of the London water companies' regulations. There always remains a small quantity of dirty water in the waste, between the inlet and the waste cock, which washes back into the bath when the hot or cold taps are turned on. The proper plan is to fill the bath by over-hanging taps at the foot, immediately over the spot where the waste outlet should be fixed. The waste of the bath should not deliver over the well of the safe, as by this arrangement the bath takes a much longer time to empty than it should do; the dirty water is also apt to flow back into the safe, and the stale soap left behind in the tray smells.

50. *Recommendations.*—The ceiling and lead flat over should be cut away, and a large skylight with the centre to open should be fixed on lead flat, after the removal of cistern **G**, par. 14, as shown on plan. A portion of the floor of the box-room should also be cut away, and a stud partition, lathed and plastered on each side, should be fixed across the end of this room to form a shaft to light and ventilate the bath-room. The old w.c. **L**, par. 28, should be done away with entirely, and the partition between it and the bathroom removed and the work disturbed made good. A best enamelled cast-iron parallel bath (**V**), 5 ft. 6 in. long, should be fixed in place of the existing zinc one, and a new mahogany top fitted to same, or the old top adapted if possible. The old lead safe should be removed for the necessary alterations to the supplies and waste; it can then be repaired and refixed, and a 1¼ in. overflow carried under the floor of the back bedroom, to deliver through the external wall, the end being fitted with a flap valve. Should the position of the joists be found to prevent this, this overflow may be connected with rain-water pipe **B**, par. 5, under the stairs, but the former way is much to be preferred.

51. The 1½ in. lead-bath waste **P** should be carried down in casing with hot-water pipes continued under the floor of the servants' hall into a strong 2 in. cast-iron drain-pipe laid on 6 in. of concrete, to deliver over the gully **X** in the middle area. The connexion between the lead and iron pipes should be made by means of a brass thimble, par. 5, and a caulked metal joint, the lead waste to have two strong cast-lead tacks fixed every 5 ft., and protected from the hot-water pipes by a coating of asbestos. The waste may be fitted with a patent quick action, with secret overflow—i.e. improved copper waste with trap. (Fig. 20.) This waste should be continued up in the corner of the new air-shaft and carried to about 5 ft. above the lead flat and finished with a + copper-wire guard.

FIG. 20.



Note v.—The bath waste is still a matter of difficulty to the plumber. The principle usually adopted is shown in illustration No. 20. It will be seen that the internal tube, or standing waste, regulates the height at which the water will stand in the bath. Directly the water rises above the level of the top of this tube it escapes down it into the trap and waste-pipe below. The bottom of this tube is usually provided with an india-rubber seating, and forms the seal that retains the water in the bath. Upon lifting this tube, which is done by means of a short chain and handle, the whole of the water escapes. The great objection to this arrangement is that soapy matter accumulates in and around this standing waste, and there is usually considerable difficulty to gain access to the interior to clean it. In selecting a bath it should be borne in mind that ready access to the inside of this waste is an important feature. A large majority of the baths sold have a somewhat similar arrangement to the above, cast in iron at the end, as part of the bath. In this soapy matter accumulates even more quickly than in the copper waste.

The illustrations show two attempts that have been made to mitigate the evil of the standing waste. In Fig. 21 a lever valve, similar to that used in a valve closet, is fixed at V to retain the water in the bath. This arrangement leaves a clear course to the trap and waste for any water to escape down the overflow pipe O, and to which there is a ready means of access, provided, at the same time, it does away with the objectionable practice of allowing the overflow to be filled with more or less dirty water.

FIG. 21.

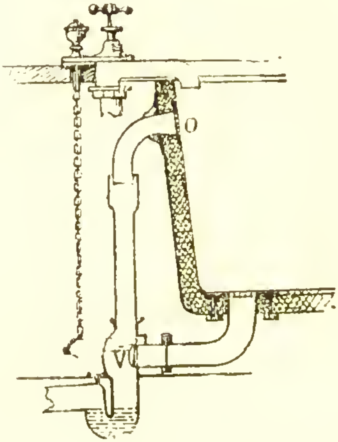
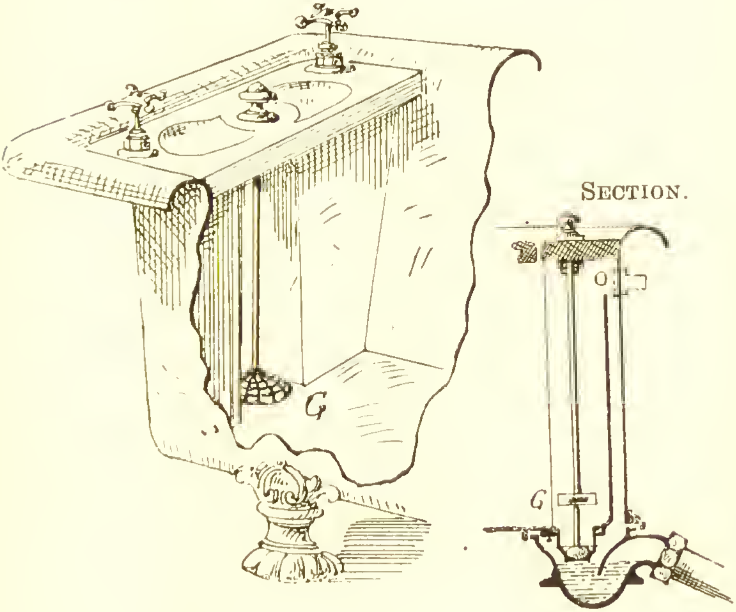


Fig. 22 is one of the simplest arrangements if, instead of the standing waste shown in the diagram, a separate, short overflow connected at O is carried through an external wall with a draught valve on the end. This pipe should also be fitted with a brass cleansing cap and screw, though as a matter of fact a bath is seldom filled so full as to overflow.

In the illustration the overflow tube under O forms part of the casting of the bath, as this enters the trap on the outfall side of the waste plug. The water standing in the bath cannot circulate in it, as is the case in the first illustration. No doubt when the plug is lifted some water would wash up into this overflow tube, but to cleanse this a small flush-pipe is fitted to deliver over the top, which acts whenever one of the taps is used. The trap is of cast iron, made with a vitreous lining, and the grating that conceals the plug is fixed with a bayonet joint, and can be easily lifted up to cleanse the trap. This arrangement is not, however, supplied separately from the bath. Considerable care should be used when fixing iron traps or pipes that have vitreous linings that the lining is not broken, otherwise their utility is destroyed.

The cold supply should be by a **1** in. lead branch from the 1¼ in. down service from cistern **G**, par. 15, to the basement. The hot-water supply should remain, but the taps would each be plated, overhanging, screw-down taps. If a lever tap is used vibration often occurs, though this may be prevented by the use of an air vessel at the end of each supply pipe.

FIG. 22.



SECTION.

52. *The Hot Water System.*—The hot water is supplied from the kitchen boiler by a **1** in. iron flow and return pipe to a 50 gallon closed galvanised iron tank fixed in the bath-room, from which an exhaust pipe is carried up to above the level of Cistern **G**, par. 13, and packed with felt. A trapped branch is carried from this cistern into the return

pipe to the boiler immediately under the cistern, whilst a small pipe is continued from the flow pipe to supply the housemaid's sink **Q** under the stairs. There is no safety-valve to the kitchen boiler.

Note w.—The supply of the cold water for the hot water system should not be drawn from the same cistern as that which supplies the w.c. (as in this case). The position of the exhaust-pipe is one fraught with great danger, especially as no safety-valve has been provided to the kitchen boiler. The level of the water in this exhaust-pipe will be the same as that of the water in cistern **G**. If the range was in constant use, and the water in this pipe kept above freezing point, all would be well; but in time of severe frost, if the fire had not been alight for a time sufficient to allow the water to freeze in the exposed exhaust pipe, and should the cold supply also be frozen, when the fire was lighted nothing could prevent a disastrous explosion. Again, a 1 in. flow and return pipe from the kitchen boiler is too small; should both the ends become choked by fur an explosion would result.

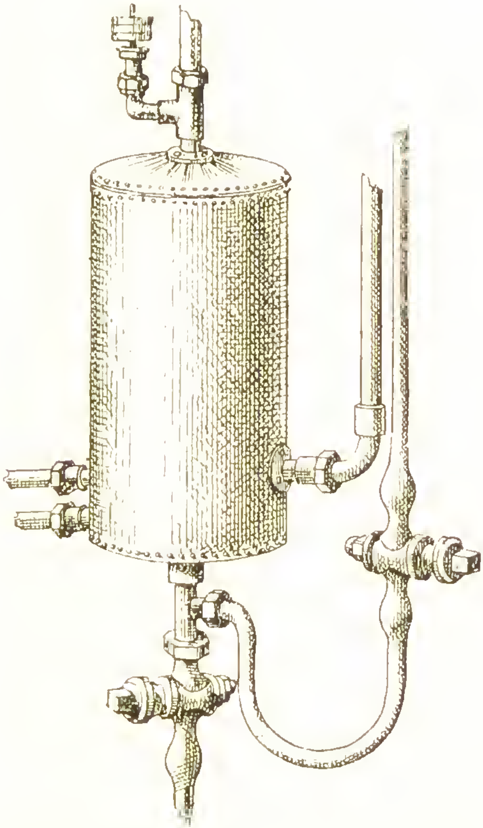
A much better supply of hot water can be had from a large cylinder fixed close to the kitchen range than by the present arrangement of the hot-water tank in the bathroom. The exhaust-pipe should be turned over the top of the supply-cistern in the roof and covered with felt.

53. *Recommendations.*—1. Disconnect the present hot-water pipes from the kitchen boiler. Fix at the side of the kitchen range, on a strong wrought-iron frame or on brackets, a 50 gallon strong galvanised iron circulating cylinder, **II** on plan. (Fig. 23.) Drill for and connect this with the boiler by a 1½ in. flow and return steam-tube, and connect the service, properly trapped, from cistern **G**, par. 15, into the return pipe. Provide a strong gun-metal stopcock to shut off the cold supply with a square-head and spanner, which should be fixed above the trap in the cold supply. (This spanner must be in the charge of some responsible person, that the cock may not be tampered with and an accident caused.) Bring down a short length of pipe with bibcock on end to empty cylinder; connect the old 1 in. flow-pipe on to the top of the cylinder and the old return pipe into the lower part of it. Encase the cylinder with asbestos (to prevent loss of heat), and leave the inspection plate to same free. Carry up a short 1¼ in. pipe from the top of the cylinder and fix on the end of same a dead-weight safety valve. In this position the valve will be more accessible, and less liable to become corroded with dirt, than if placed in the chimney; or should the valve be taken directly off the boiler, which most authorities insist upon, it should be brought through the chimney breast. When the boiler is charged lift the weight of valve, that this pipe from the boiler may be charged also, or steam will generate in it.

Note x.—Should the position of the cold-water cistern ever render it likely to be affected by frost, this arrangement must be modified by fixing a small disconnecting cistern, in some lower and more sheltered position, just above the level of the highest point, for drawing off the hot water. This will reduce the height of the water in the exhaust-pipe. At the same time it is best for the cold supply to enter the hot-water system as illustrated.

More attention than is customary should be given to the periodical removal of incrustation from kitchen boilers. The fur that adheres to the apparatus not only acts as a non-conductor of heat, which results in waste of fuel and damage to the boiler, but the orifices of the pipes connected with it often become so choked as to prevent the circulation of the water, and increase the risk of an explosion. The more efficient the apparatus the oftener will it require attention. The hardness of the water and the quantity used will also make a great difference as to how frequently the boiler should be cleaned. This must be a matter of individual experience.

FIG. 23.

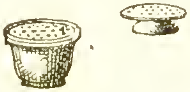


54. *Recommendations.*—1. Remove the old hot-water tank **A A** from the bathroom and continue the flow- and return-pipes to supply the housemaid's sink **Q**, with a 1 in. branch from the flow to supply the bath **V.** Provide a screw-down $\frac{3}{4}$ in. bib-valve to supply the sink. Connect and continue exhaust pipe up into the cistern room and turn same over the cistern **F.** The use of a small expansion box is very desirable at this point, otherwise if the apparatus is efficient a good deal of the hottest water will overflow into the cold water cistern through the expansion pipe. Where these pipes pass in the same casing with lead pipes, they must be covered with asbestos or other good non-conducting material (see par. 35). Provide a screw-down stopcock fixed under the bath in both hot and cold services.

55. *Drains.*—The drains throughout are of soft earthenware pipe, badly jointed in mortar. The main drain from front to back is a 9 in. pipe, and is laid in an old brick barrel drain, the top of which has been removed; the principal branches are of 6 in. pipe, and the smaller ones of 4 in. The branch drains have been laid without concrete beds and have sunk in several places. This is particularly the case in the servants' hall, where there is a large accumulation of deposit and water under the floor.

56. *Kitchen.*—There is a bell-trap (Fig. 24), **W** on plan, in the hearthstone under the boiler tap (see Note Q, par. 41).

FIG. 24.



Bell-trap.

57. *Scullery.*—See sink **R**, pars 41 and 42, and w.c. **N**, pars. 31 and 32.

58. *Cistern Cupboard.*—See cistern **H.**

59. *Back Area.*—There is a square built brick trap into which the rainwater pipe **E**, par. 9, from the flat dips; also a square cast-iron D-trap **X** in the centre of the area; the whole trap is loose and can be lifted by the hand.

60. *Servants' Hall.*—See sink **S**, par. 43.

61. *Wine Cellar.*—See soil-pipe **P**, par. 35.

62 *Foot of Staircase.*—See rain-water pipe **B**, par. 4.

63. *Housekeeper's Room.*—See sink **U**, par. 47. There is a bell-trap **W**, fig. 24, under the boiler tap by the hearth. (See Note Q, par. 41.)

64. *Pantry.*—See sink **T**, par. 45.

65. *Front Area.*—There is a bell-trap, **Y**, fig. 18, Note Q, in the centre; also one under the tap from the old lead cistern **I.** The old brick-built dust-bin under the stairs is much broken and the bricks are in a very offensive condition.

66. *Front Cellar.*—See w.c. **O**, par. 33. The urinal in the cellar must be done away with entirely, as it will be quite unnecessary with the new w.c. There is a large brick-built catch-pit or trap **Z** formed with dip-stone across the same; it has a very large quantity of deposit at the bottom. The drain from here to the sewer is a 14 in. brick barrel drain, into which the pipe from the w.c. falls; this is on the sewer side of the trap.

Note Y.—These drains are so defective that it is quite unnecessary to test them with water; they are sealed at every point, and comment upon them is needless.

67. *Recommendations.*—Provide for the temporary removal of rain-water. Take up the stone and wood floors as necessary; clear out and cart away old drains and dig out and remove all wet or foul earth, as well as the old brick drain and catch pits. Fill in the ground with dry brick rubbish and lime and make good with brickwork in cement all openings in the walls after removal of the old drains.

Dig out the ground and form all trenches with proper fall, the highest end of the drain to be kept, if possible, 18 in. below the ground level. This trench is to be made sufficiently wide at the bottom to allow a man to walk with one foot on each side of the drain, to avoid treading upon it.

Lay, as shown on plan, between the middle and front areas, upon 6 in. of cement concrete, a 4 in. stout cast-iron drain, coated internally with Dr. Angus Smith's solution, with caulked metal water-tight joints and a regular fall of not less than 2 in. in 10 ft., but where possible the fall should be 2½ in. to 3 in. in 10 ft. Form in the front area, where shown on plan, on a 6 in. bed of concrete a proper disconnecting chamber **CC** (see illustration to Note Z ii), 9 in. work in hard stock bricks in cement, 3 ft. long by 2 ft. 6 in. wide inside measure. On the bottom of this, in the line of the drain-bed, lay a taper contracted outlet channel pipe, with a fall from 4 in. to 6 in. in the 3 ft. length, in order to secure a smart flow into the syphon trap (see note Z ii), and at the bottom end of same provide and fix on proper cement concrete bed a syphon with a 4 in. contracted inlet and 5 in. outlet. Bed the stopper of the inspection eye with grease. (See Note Z, also Note KK in Example II.) Connect the various branches from the w.c.'s and gullies, as shown, and bring them into the manhole in white-glazed curved 4 in. channels, with a sharp fall of 5 in. or 6 in. into the bottom. These branches are to be all of 4 in. London stoneware glazed drain-pipe (see note Z), laid on a 6 in. concrete bed with cement water-tight joints. Each pipe should be laid upon two flat bricks, one placed just behind the collar and the other at the extreme end; this allows the hand to be passed round the pipe more easily than if laid on the ground, an advantage both when the joint is made and also in the event of a leakage. It likewise prevents the weight of the pipe squeezing out the cement when new. Make good the bottom divisions and the slopes of the chamber in brickwork, and cement the whole of the interior.

Provide a 4 in. pipe air-inlet **EE** to the manhole from the top of same and carry up in chase a galvanised iron pipe in the front area wall fitted on the top with a galvanised box and grating.

Provide and fix on the top of the disconnecting-chamber a strong, cast-iron, galvanised, lifting, air-tight frame and cover. Connect on to the outlet from the syphon trap a 5 in. to 6 in. socket, and lay a 6 in. London stoneware pipe drain with cement joints into the sewer, the last pipe to have an inspection eye that this pipe of drain may be tested to the manhole before filling in ground.

Note Z.—5 in. drains are in more general use, but where only one $3\frac{1}{2}$ in. soil-pipe exists to ventilate the drains it is better to use the 4 in. drain. A drain of this size is quite sufficient for the requirements of any house similar to the one under consideration, and it will be more in accord with the London County Council by-law which provides that the ventilating pipe shall be of equal dimensions with the drain. It is, however, of great importance in using so small a drain that all closet traps should be well ventilated. A 4 in. drain, with a fall of 1 in 65 when running full will discharge 204 gallons per minute, much more than this drain can ever be required to do. In using iron drains it is generally found that when they rust at all it is from the outside, hence the importance of covering them with Portland cement concrete, particularly if in a damp situation.

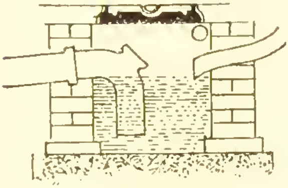
68. *New Area.*—Provide and fix a gully **AA** and carry a 4 in. drain, as elsewhere described, to deliver into side of flushing gully in middle area. Pave this area with 2 in. York stones laid and pointed in mortar.

69. *Middle Area.*—A 12 in. fat-trap flushing gully is to be fixed by the new window, the top to be 16 in. below the

level of the pavement, which is to be dished and rebated to receive an iron grid to take off the surface water. Where the fall will not admit of the gully being at this depth the top may have a cast-iron cover screwed down, or the flushing arrangement must be modified to meet the requirements. If a screw-down cover is used the gully will require a short ventilating pipe.

Provide and fix a gully at **X** to take waste-pipe from bath, also one to take the waste of sink **S** in servants' hall ; it is perhaps scarcely necessary to have both gullies, but **X** is put for the better drainage of area. Connect this gully into the end of new chamber and connect also with the waste pipe from the scullery sink.

Fig. 25.



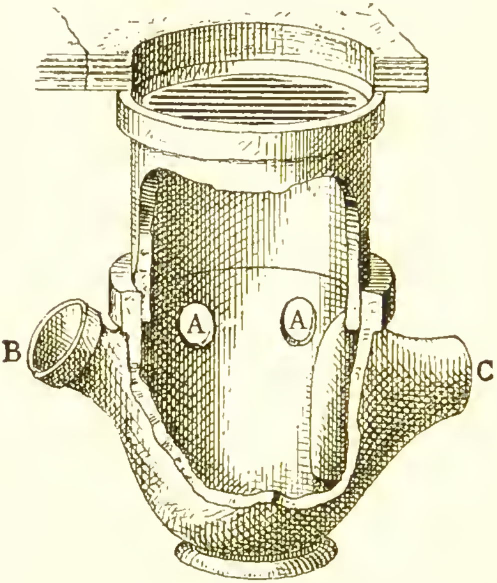
Old Fat-trap.

Note z i.—The brick-built fat-trap (Fig. 25) is now quite discarded by modern plumbers, though till within the last few years it was looked upon quite as a necessary adjunct. It was but a stepping-stone to the flushing-gully. One of the earliest things attempted was that the fat and sand from the scullery sink should not be allowed to foul the drain, and this the fat-trap accomplished effectually, but the fat-trap required regular attention—that is, some three or four times a year it had to be emptied, and the cover examined to see that it was air-tight. It was, after all, but a make-shift and a remedy but little removed from a disease. The flushing gully (Fig. 26) works automatically in connexion with a flushing tank, and our attention now is transferred to this latter. As these tanks at times have a habit of not fulfilling their mission, it is well to have them furnished with a plate-glass side so that their action or otherwise may be observed. As a rule they may be relied upon where the supply is from the main direct or from a cistern at a much higher level. They fail when there is want of a sufficient flush of water at the last moment to set up the action of the syphon. They are usually fitted with a reverse action ball valve—that is to say, when the ball is at the lowest point the water is shut off. The cistern is filled by means of a very small tap that can be regulated to charge it in any given time. When the cistern is nearly full the risen water lifts the ball, and the water rushes in through the valve and starts the syphon. The force of some 25 or 30 gallons of water conducted into the gully by a 2 in. or 3 in. lead pipe breaks up the fat, which has collected and hardened, and it is rolled away down the drain without trouble. It is well before fixing the apparatus to hear from any water company which particular form of apparatus meets with their approval.

Provide a 30 gallon automatic action, galvanised iron flushing tank with glass front, and fix on strong wrought-iron brackets in the kitchen about 8 ft. from the ground. This is to be supplied by a ½-in. branch pipe from the main supply to the house, fitted with a special valve, if required by the water company, or by a reversed action ball-valve. Carry down a strong 2 in. lead pipe into the back of the new flushing gully.

70. *Manhole* **Z.**—Build an inspection chamber, as described for front area, omitting the syphon trap and fresh-air inlet. Generally provide and fix stoneware self-cleansing gullies, and carry pipe drain branches from these and from the w.c., as before described, into the new inspection chamber, as shown on plan. It frequently happens—as in the City—that these have to be placed within doors. In this case the chambers should be fitted with patent "lever-locked," cast-iron, intercepting or inspection chambers. These have the advantage of increasing the draught through the drain, which is always somewhat impeded by the air space in the manholes; but, on the other hand, the traps must be most carefully ventilated, as the air-cushion provided by the manhole is absent. In all cases where the drains are not out of doors they should be of iron throughout, and where expense is not a matter of import-

FIG. 26.



Flushing gully.—A, Inlet from sinks, &c.; B, Connexion to flushing tank; C, Ditto to drain.

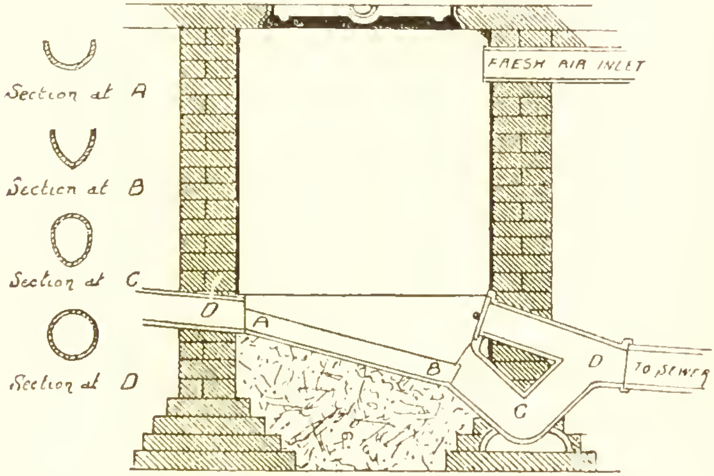
ance they may be left exposed in a brick trench, much in the same way as hot-water pipes are treated. After the drains have been tested with water and found sound, cover over with concrete before the earth is replaced.

Note z ii.—The ventilation in the drain is supposed to take place by the admission of fresh air in the short arm placed in the disconnecting chamber, which escapes through the soil- and ventilating-pipes at the extreme end of the drain. As a rule this will be the case, but where the disconnecting chamber is situated on the south side of the house the upcast pipes would be due north, in which case the natural tendency of the air currents would tend in the contrary direction. The air on the north side would be colder and heavier than that in the front, which would be warmed by the radiation from the front of the house. In such a case it is better to carry up the otherwise short inlet-pipe to the top of the house and reverse the current; the inlet would then be at the back. Of course, whenever the w.c.'s are used in either case air is drawn down the soil pipe.

All soil- and ventilating-pipes should be closed at the lowerend before connexion with the drain, and the top of each closet trap sealed that they may be filled to the top for the water test.

The section and plan of the disconnecting chamber given in Figs. 27 and 28 indicates the principal points to be observed in its construction.

FIG. 27.

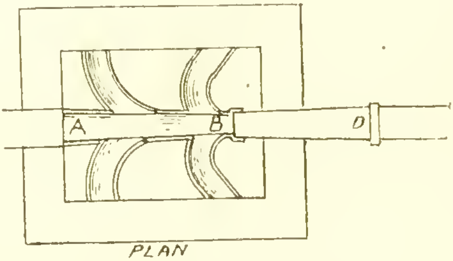


Disconnecting chamber.

The syphon should have a large water seal and nothing to impede the flow. By the addition of a little grease with the putty used in cementing the inspection cover to the eye of the syphon the same can be readily taken out if required without fracture, or, for preference, use a piece of slate bedded in cement; this can easily be broken and replaced with a fresh piece when an inspection is desired. The extra fall allowed in the channel-pipe quickens the flow of sewage into the trap, which is also assisted by the egg-shaped outlet of the channel-pipe and the inlet to the syphon. (See par. 67.) The cement on the sides, &c., of the chamber must be thoroughly well trowelled.

71. On the completion of all work the drains and manholes should be tested with water. This can be done by sections from one manhole to another. In this final examination an electric bull's-eye lamp will be found useful, as it allows any rough internal surfaces to be seen at once. It frequently happens that when the manholes are built some of the cement used is washed into the drain. This cakes round the joints, and unless discovered and removed will soon cause a stoppage. If a lamp connected with an accumulator is placed at the end of the drain and a small piece of looking-glass held at an angle at the other end, the whole of the interior can be distinctly seen, provided the drain is straight. In fact, a patent has been granted to the inventor of a small carriage on which such a lamp is placed, and this can be pushed round a bend by means of a jointed rod. This arrangement, with an attendant, can be hired of the patentee. After the manhole covers have been bedded down in Russian tallow the soil-pipes and drains should be finally tested by means of smoke or chemicals.

FIG. 28.



PLAN

Remove the front of the old brick dustbin and thoroughly clean down the brickwork to the back and sides; point in cement, and twice lime-white. Provide a suitable portable, galvanised, wrought-iron dustbin.

Note z iii.—It is of the utmost importance to see that the drains are laid upon a proper concrete bed, as in the event of a settlement the joints are sure to break and the entire value of the work to be destroyed.

In the arrangement of a plan for the pipes there are several things to be borne in mind. It is well to keep every drain perfectly straight, so that it may be seen from end to end like a gun-barrel; but if it is necessary to have a bend it should be placed next to the inspection chamber. Again, when possible let each short drain enter the manholes separately, but avoid long lengths of dead drains without ventilation at the upper ends; rather have two branches connected than do this. In the case of w.c. O the drain to the manhole is 6 ft. long and unventilated, therefore we use a 6 in. pipe, as the charge from the closet will be less likely to syphon the trap than if a 4 in. pipe is used. Arrange, if possible, that each gully trap is fed from a sink, so that the water in the trap may be renewed in any weather.

It cannot be too strongly urged that the surest way of removing foul gas is to keep a current of fresh air continually in movement through the drains and soil-pipes.

The size, the length, and the number of bends in a pipe all greatly affect the velocity with which air will travel through it. In the case of a rush of water down a soil-pipe the inlet or exit of the air must be as easy and free from obstruction as possible. In order to meet the sudden demand, it will certainly make its way through the point of least resistance, and in many cases this is past the agitated water of the nearest trap back into the room, or by the withdrawal of the water entirely, the trap being afterwards left unsealed. When it is remembered that the resistance to the motion of air caused by friction in a pipe is in inverse proportion to the diameter, it will be at once apparent that a small pipe is much less useful for the purposes of ventilation than a large pipe.

72. *Taps.*—The question of taps is one of considerable importance. Within the last year or so a tap has been in use that is a decided improvement upon the old ground-in taps made entirely of metal. The friction was continuously in one spot, and any grit that lodged between the metal surfaces soon caused the tap to leak. This was particularly the case in the hot-water taps. The sharp particles of carbonate of lime,—precipitated in the hot water after the heat had expelled the carbonic acid gas which held the lime in solution,—in a few weeks would cause the best ground-in taps to leak. The more modern screw-down high-pressure valves fitted with a vulcanite seating are but little better. The seating often becomes fixed if the tap is not in frequent use, and the vulcanite requires to be constantly renewed. By a simple and ingenious arrangement this is avoided, and the modern ones present a constantly varying face in the metal seating, a contrivance which is likely to result in a much longer life to the tap. In the case of all draw-off taps the patentee has been enabled to do away entirely with the packing through which the screw-down handle works; this packing is always a cause of trouble through leakage. Working on somewhat similar lines, these taps have been still further improved upon by another patentee, whose bib and self-closing valves—the latter made upon the equilibrium principle—bid fair to supersede all others at present in use.

ESTIMATE

For proposed Alterations and Sanitary Work as explained in Specification and shown on Plans. (EXAMPLE I.)

Work in connexion with the Rain-water Pipes.

		£	s.	d.
Disconnect the rain-water pipe **A** from drain (carrying off water from front gutter), cut pipe or fix new length as required, and connect with easy bend into side inlet of new gulley (drain measured elsewhere)... ...	6/3	0	6	3
Clear away the present rain-water pipe **B** from flat between the two roofs, and give credit for same at end of bill	6/-	0	6	0
53 ft. run, 3½ in. 8 lb. lead rain-water pipe fixed with four cast lead tacks to each length and soldered joints carried down casing at	4/4	11	9	8
24 ft. run, 4 in. Doulton's tested stoneware drain-pipe, the joints made with sand and cement laid on a bed of Portland cement concrete 6 in. thick, including digging; average depth 12 in., and covering with 6 in. of concrete, and taking up floor, relaying, and making all good at completion (this price may vary according to the condition of old floor) at per ft.	3/9	4	10	0
Connect rain-water pipe to drain-pipe with easy bend, and brass collar with necessary joints	12/6	0	12	6
1 connexion of 4 in. drain-pipe with gully **F F**... ...	1/3	0	1	3
Disconnect rain-water pipe **C** from soil pipe (carrying off water from back of house), cut pipe or put new length as required, and make same to discharge on flat over study	12/6	0	12	6
Disconnect rain-water pipe **E** from drain (carrying off water from flat over study), fit shoe and make same to discharge over new gully (the removal of the portion used as soil-pipe is taken in)	12/6	0	12	6

Work in Connexion with Cisterns.

		£	s.	d.
For forming dormer enclosure in roof to hold cisterns, as shown on plan and described in specification		25	0	0
Remove 150 gallon lead-lined cistern **F** with its connexions and refix same in altered position in new dormer enclosure, and properly seal off all old connexions ...	25/-	1	5	0
1 ft. 6 in. run, 1½ in. lead overflow carried through wall into external gutter on flat	1/8	0	2	6
1 1½ in. lead joint to pipe passing through cheek of lead lined dormer	2/10	0	2	10
45 ft. run, 1½ in. stout lead service pipe from cistern to second floor, with all necessary bends, &c.	1/9	3	18	9
1 hole in cistern and lead joint	4/4	0	4	4
1 1½ in. screw-down stopcock and soldered joint, fitted with brass union at each end	35/-	1	15	0
16 ft. run, 9 in. by 1 in. deal wrought and beaded casing and backings, with brass cups and screws, and painting (four oils)	1/5	1	2	8

Fit about 8 ft. super. of ¾ in. matched boarded ledged cover and 1 in. frame to cistern, the flap to be hung with cross garnet, and painting same (four oils)	15/6	£0	15	6
Remove the old slate cistern **G** and its connexions and give credit for same at end of bill	12/6	0	12	6
Provide and fix a 300 gallon galvanised iron cistern ⅛ in. plate and allow for hoisting and fixing in new dormer enclosure 40 ft. above ground floor level	175/-	8	15	0
92 ft. run, 1¼ in. lead pipe from cistern to kitchen in basement with all necessary bends, and carried down alongside old hot-water pipes	1/5	6	10	4
1 in. branch from pipe to cylinder, about 10 ft. long, with sharp bend in same and make necessary connexion	25/-	1	5	0
5 ft. run, encase pipes with hair felt, passing through water-closet, secured with copper wire	-/6	0	2	6
1 1¼ in. brass union, hole drilled in cistern and joints	8/3	0	8	3
1 1¼ in. screw down stopcock and brass union and joints at each end	26/3	1	6	3
5 ft. run, 1½ in. lead overflow from cistern carried through wall into external gutter on flat	1/8	0	8	4
1 1½ in. brass union and hole drilled in cistern and joints	9/4	0	9	4
1 1½ in. solder joint to pipe passing through cheek of lead-lined dormer	2/10	0	2	10
40 ft. run, take down present pipe casing, and refix same with brass cups and screws	-/4	0	13	4
7 ft. 6 in. run, 1 in. deal wrought and beaded easing on third floor fixed with brass cups and screws and paint (four oils)	1/6	0	11	3
12 ft. run, ¾ in. lead supply to housemaid's sink	1/1	0	13	0
2 ¾ in. soldered branch joints	1/10	0	3	8
1 ¾ in. screw-down bibcock, of good make, to housemaid's sink and joint	10/-	0	10	0
Remove the lead-lined cistern **H** in cupboard under ground floor, and give credit for same at end of bill	6/3	0	6	3
Fix 100-gallon galvanised iron cistern ⅛ in. plate and fix same in position in new larder on strong fir bearers cut and pinned into wall	81/-	4	1	0
6 ft. run, 1 in. lead supply from cistern in larder to scullery sink	1/3	0	7	6
1 1 in. brass union hole drilled in cistern and joint	6/10	0	6	10
1 1 in. screw-down bibcock of good make and joints	12/6	0	12	6
1 ft. 6 in. run, 1 in. lead overflow carried through external wall into area	1/2	0	1	9
1 1 in. brass union hole drilled in cistern joint	6/10	0	6	10
Remove the old cast lead cistern **I** at end of front area, and give credit at end of bill	12/6	0	12	6
Provide and fix 50-gallon galvanised iron cistern in same position as the old, but at higher level, fixed on strong fir bearers cut and pinned into wall	50/-	2	10	0
Case the above with felt and ¾ in. matched boarding with lid on top for access to cistern	30/-	1	10	0
107 ft. run, ¾ in. lead main supply and fixing with wall hooks and all necessary joints	1/1	5	15	11
49 ft. run, ¾ in. ditto branches to cisterns ,,	1/1	2	13	1
1 ¾ screw-down stopcock with joint and brass union at each end	13/9	0	13	9
4 ¾ equilibrium ball valves, joints and fixing	10/-	2	0	0
4 ¾ brass unions, hole-drilled in cistern and joints	5/-	1	0	0
4 branch joints	1/10	0	7	4
59 ft. run, encase all pipes exposed in roof with felt secured with copper wire	-/6	1	9	6

Work in Connexion with Water-closets.

Clear away the closet J on third floor and make good all work disturbed … … … … … …	17/-	£0	17	0
Form new water-closet with stud partition, plastered both sides, fitted with doors, lining complete, and for cutting opening through external wall forming new window opening, all as shown on plan … … … …		18	10	0
1 qr. 20lb., 4lb. lead safe under closet .. … …	22/6	0	9	9
3 ft. run, labour dressing over fillet, including copper nailing … … … … … … … …	-/4	0	1	0
3 ft. run, 1½ ft. 1 in. deal fillet … … . …	-/2	0	0	6
2 ft. run, 1¼ in. lead waste-pipe from safe carried through external wall … … … … … …	1/4	0	2	8
1 in. copper flap and soldering … … … …	1/6	0	1	6
1 1¼ in. soldered joint, lead pipe to safe … … …	2/6	0	2	6
Provide and fix in position a combination pedestal closet with earthenware slop top, white basin with flushing rim, supported on lead cone, with hinged seat and brackets complete … … … … …	110/-	5	10	0
1 galvanised 3 gallon syphon silent water waste preventer, with brackets, chain, and pull … … … …	43/6	2	3	6
5 ft. run, 1¼ in. lead flush pipe from water waste preventer to closet, including joint and fixing with cast lead tacks soldered to pipe at … … … … … …	1/10	0	9	2
2 ft. run, ½ in. lead supply to water waste preventer …	-/9	0	1	6
2 ½ in. soldered joints at … … … … …	1/7	0	3	2
1 ½ in. screw-down stopcock, joint and brass union at each end … … … … … … … …	8/9	0	8	9
2 ft. 6 in. run, ¾ in. lead overflow from water waste preventer carried through external wall .. … …	1/1	0	2	9
1 8 lb. lead P. trap and joint to hopper … … …	18/9	0	18	9
1 short branch of 3½ in. 10 lb. lead bent pipe 2 ft. 6 in. long, carried through external wall and soldered at one end to lead trap and the other to soil pipe … … …	25/-	1	5	0
Form new closet **K** over well of staircase, with stairs and landing to reach same, with opening cut in external wall, and new sash and frame fixed therein, all as described in specification and shown on plan ..	540/-	27	0	0
32 ft. super, take up flooring and put sound boarding and lime and hair pugging … … … … …	-/8	1	1	4
3½ yds. super, provide and lay tile floor prime cost value 12/- per yard, and include for Portland cement floated surface … … … … … … …	21/-	3	13	6
21 yds. super, prepare and render walls in cement, provide and fix white glazed tiles, in Portland cement, prime cost value 10/- per yard … … … … …	19/-	19	19	0
Provide and fix a valve closet with 1¼ in. valve, with separate supply to overflow and fix same in position, as shown on plan, and 1½ in. ventilation pipe and brass union to valve-box … … … … …	120/-	6	0	0
3 ft. run, 1½ in. lead ventilating pipe from valve-box carried through external wall … … … … …	1/8	0	5	0
1 1½ in. soldered lead joint … … … … …	2/10	0	2	10
2 ft. run, 1¼ in. lead flush pipe to w.c., taken from 1½ in. down service, and cast lead tacks soldered to pipe …	1/10	0	3	8
2 1¼ in. lead soldered joints … … … … … …	2/6	0	5	0
1 1¼ in. screw-down stopcock and soldered joint, both ends with unions (as above) … … … … …	26/-	1	6	0
1 3½ in. 8 lb. lead trap with soldered joint and fixing to closet … … … … … … … …	16/-	0	16	0

Short branch of 3½ in. 10 lb. lead bent pipe, about 4 ft. 6 in. long, with soldered joint at one end to trap and at the other to soil pipe	34/-	£1	14	0
Adapt and alter (or supply new) seat and riser as may be required to suit new valve closet, and make same moveable by hanging on hinges for easy access to apparatus	25/-	1	5	0
2 qr. 16 lb. 6 lb. lead safe under closet	22/6	0	14	3
3 ft. 6 in. run, 1¼ in. lead waste from safe carried through external wall	1/4	0	4	8
1 1 in. copper flap and soldering an end of pipe	1/6	0	1	6
1 1¼ in. soldered joint to tap	2/6	0	2	6
Paint three coats with oxide of zinc paint, the whole of wood and plaster work under seat	7/6	0	7	6
Remove the old w.c. and its connexions, and make good all work disturbed	20/-	1	0	0
Remove the old Bramah w.c. **L** next bedroom, and make good all work disturbed (this closet will now not be required)	20/-	1	0	0
Remove the old closet **M** on ground floor with its connexion, make good all work disturbed	20/-	1	0	0
Form new w.c., with partition, door, sash, and frame, all as described in specification and shown on plan ...		12	10	0
15 ft. super. Take up flooring, lay sound boarding, and lime and hair pugging...	1/-	0	15	0
1¾ yds. super, provide and lay tile floor, prime cost value 12/- per yard, and include for Portland cement floated surface	21/-	1	16	9
Provide and fix a pedestal closet with 8 lb. lead syphon trap, with mahogany flap and paper box, and fix in position	120/-	6	0	0
1 short branch of 3½ in. 10 lb. lead bent pipe, about 2 ft. long, connected at one end with brass thimble-piece and soldered at other end to soil-pipe	27/6	1	7	6
1 3 gall. syphon silent water-waste preventer, with bracket, plated chain, and pull	50/-	2	10	0
6 ft. run, 1¼ in. lead flush pipe from water-waste preventer to closet, and fixing with cast lead tacks soldered to pipe	1/10	0	11	0
2 1¼ in. soldered joints	2/6	0	5	0
29 ft. run, 1 in. lead pipe from second-floor landing to basement, with all necessary joints, wall hooks, and fixing	1/3	1	16	3
22 ft. run, 1 in. wrought and beaded casing, fixed with brass cup and screws, and painting same (four oils) ...	1/4	1	9	4
4 ft. run, ½ in. lead supply to water-waste preventer ...	-/9	0	3	0
1 ft. 6 in. run, ¾ in. lead overflow to water-waste preventer...	1/1	0	1	8
2 ½ in. soldered joints	1/7	0	3	2
1 ¾ in. soldered joints	1/9	0	1	9
Remove sink **R** and closet **N**, cutting away lead flat over to form open area lined with white glazed tiles; cut doorway into kitchen, build walls to form new larder and scullery; all as described in specification and shown on plan		80	0	0
Provide and fix new w.c., marked **N** on plan, in basement, a pedestal closet with flushing rim basin properly fixed, the closet to have deal hinge flap to lift up	40/-	2	0	0
25 ft. of 2 in. lead anti-syphonage pipe into that of w.c., marked **M**	2/6	3	2	6
1 2 in. brass sleeve piece	2/6	0	2	6

2 2 in. soldered joints...	3/4	£0	6	8
1 3 gallon syphon flushing water-waste preventer, with brackets, chain, and pull	37/6	1	17	6
5 ft. run, 1¼ in. lead flush pipe from water-waste preventer to closet, and tacks and soldering	1/10	0	9	2
2 soldered joints to above	2/6	0	5	0
8 ft. run, ½ in. lead supply to water-waste preventer ...	-/9	0	6	0
2 ft. run, ¾ in. lead overflow to ditto	1/1	0	2	2
2 ½ in. soldered joints ...	1/7	0	3	2
1 ¾ in. soldered joints ...	1/9	0	1	9
1 ½ in. screw-down stopcock and unions, soldered joints both ends	10/-	0	10	0
Form half-brick enclosure under vault for new w.c marked **O** on plan, with door fitted in same, all as described ...		5	0	0
Provide and fix a basin with flushing rim, all as described, to closet marked **N**	40/-	2	0	0
1 3 gallon syphon flushing water-waste preventer, with bracket, chain, and pull ..	37/6	1	17	6
5 ft. run, 1¼ in. lead flush-pipe from waste water-pipe to closet and cast tacks	1/10	0	9	2
2 soldered joints to above	2/6	0	5	0
11 ft. run, ½ in. lead supply to water-waste preventer...	-/9	0	8	3
2 ft. run, ¾ in. lead overflow ...	1/1	0	2	2
2 ½ in. joints	1/7	0	3	2
1 ¾ in. joint	1/9	0	1	9
Provide and fix 25 gallon galvanised iron cistern **I**, fixed on strong bearers, under front steps, and enclose cistern with wood lining and pack with felt...	40/-	2	0	0
2 ft. 6 in. run, ¾ in. lead supply	1/1	0	2	8
2 ft. run, ¾ in. lead overflow ..	1/1	0	2	2
2 ¾ brass unions and hole drilled in cistern and joints	5/-	0	10	0
1 ¾ in. soldered branch joint	1/9	0	1	9
55 ft. run, 3½ in. 10 lb. lead soil-pipe **BB** fixed at back of house, with all necessary joints and cast lead tacks, soldered to pipe, carried up as high as parapet ...	5/4	14	13	4
(NOTE.—This price varies somewhat, according to position of the work.)				
14 ft. run, 3½ in. 10 lb. lead soil-pipe, but fixed to slating of roof, and encased with 1 in. deal casing	6/-	4	4	0
Extra labour to 3½ in. bend ...	5/-	0	5	0
Connect soil-pipe to iron drain, with easy bend and brass thimble and soldered joint	12/6	0	12	6
1 3½ in. copper wire balloon fixed on top of soil-pipe...	3/-	0	3	0
49 ft. run, 2 in. lead anti-syphonage pipe carried alongside soil-pipe, with all necessary joints, and cast lead tacks soldered to pipe ...	2/6	6	2	6
6 2 in. branch soldered joints	3/4	1	0	0
Remove the old soil-pipe, make good, and give credit at end of bill...	12/6	0	12	6

Work in connexion with Sinks.

Clear away the small lead-lined sink **Q** under stairs of second-floor landing and give credit at end of bill	5/-	0	5	0
Provide and fix a fireclay enamelled sink **Q**, fixed on strong bracket in housemaid's closet, 42 by 22 by 10 in. ...	60/-	3	0	0
47 ft. run, 1½ in. strong lead waste carried down casing by side of rain-water pipe **B**	1/9	4	2	3
1 1½ in. lead syphon trap, with cleaning cap and screw joints...	8/9	0	8	9

24 ft. run, 2 in. strong iron pipe carried under floor of pantry, taken through external wall into gully on 6 in. concrete, the joint of pipe to be caulked with lead, make good flooring and all works disturbed ...	2/6	£3	0	0
Connect waste of sink to iron pipe with brass thimble and soldered joint	9/3	0	9	3
9 ft. run, 1½ in. lead pipe taken up from upper end of waste pipe, pass same through flat	1/8	0	15	0
2 1½ in. soldered joints to pipe and lead flat	2/10	0	5	8
1 1½ in. copper wire balloon fixed to top of pipe ...	2/-	0	2	0
4 ft. 6 in. run, 1½ in. lead anti-syphonage pipe connected with lead ventilating pipe	1/8	0	7	6
5 ft. ½ in. stout lead service	-/9	0	3	9
1 ½ in. high pressure bibcock	4/10	0	4	10
2 ½ in. soldered joints	1/7	0	3	2
2 1½ in. soldered joints...	2/10	0	5	8
3 qr. 11 lb. 7 lb. lead, and laying on floor of housemaid's sink	22/6	0	19	0
21 ft. run, close copper nailing	-/3	0	5	3
Clear away old stone scullery sink **R** with water connexion and give credit	5/-	0	5	0
(NOTE.—The hot-water supply *will* remain.)				
Form alteration in scullery to enclose sink with new window, &c.		6	0	0
Provide and fix a glazed earthenware sink, 48 in. by 24 in. by 6 in., fixed on half-brick bearer and render with Portland cement...	68/-	3	8	0
5 ft. run, 2 in. lead waste from scullery sink carried through external wall to discharge over gully	2/6	0	12	6
1 2 in. lead syphon trap, with cleaning cap, and screw with soldered joints to pipe and trap	11/3	0	11	3
1 1¼ in. anti-syphonage carried through external wall, and copper wire fixed on end of pipe, about 18 in. long	4/-	0	4	0
1 1¼ in. soldered joint...	2/6	0	2	6
1 1 in. screw-down approved pattern bibcock and joint to lead pipe	12/-	0	12	0
1 1 in. screw-down approved pattern bibcock, and joint to iron pipe	11/-	0	11	0
Provide and fix a draining board, covered pewter and fixed under plate rack, 2 ft. by 1 ft. 6 in.	31/-	1	11	0
Remove the old lead-lined sink **S** in servants' hall with its connexions, and give credit	5/-	0	5	0
Provide and fix deep glazed stoneware sink, fixed on strong fir framed bearers	43/6	2	3	6
3 ft. 9 in. run, 1¼ in. lead waste to sink, carried through external wall into gully	1/8	0	6	3
1 1¼ in. lead syphon trap, with cleansing cap and screw, with joint to lead pipe and trap	8/6	0	8	6
1 1¼ in. anti-syphonage carried through external wall, and copper wire fixed on end of pipe, about 2 ft. ...	3/-	0	3	0
1 1¼ in. soldered joint	2/6	0	2	6
1 1¼ in. brass washer plug and waste, and soldered joint	8/6	0	8	6
31 ft. run, ¾ in. lead pipe taken from 1¼ in. down service joints	1/1	1	13	7
1 ¾ in. branch joints	1/9	0	1	9
1 ¾ in. screw-down high pressure horizontal bibcock (approved pattern), and joint to lead pipe	9/3	0	9	3
1 ¾ in. screw-down high pressure horizontal bibcock (approved pattern), but joint to iron pipe	8/9	0	8	9
1 ½ in. lead pipe, about 1 ft. 6 in., to housemaid's closet from rising main; 1 ½ in. screw-down high pressure bib cock	10/6	0	10	6

Remove old lead-lined sink **T** in pantry, make all good, and give credit for old materials at end of bill	5/-	£0 5 0
Provide and fix 1 in. deal wrought sink (with division in centre) 3 ft. by 1 ft. 6 in. by 1 ft., bottom and sides to be framed and dovetailed together, and division housed to back and front and fix in position	25/-	1 5 0
Milled lead in lining and flashings to sinks	25/-	1 5 0
8 ft. run soldered seam	1/6	0 12 0
11 ft. close copper nailing	-/3	0 2 9
8 ft. run 1¼ in. lead waste to sinks, carried through external wall into gully	1/4	0 10 8
2 1¼ in. lead syphon traps, with cleansing cap "screw," joints to lead pipe, and trap	8/9	0 17 6
1¼ in. lead anti-syphonage to above, carried through external wall, with copper wire fixed to two ends of pipe, about 5 ft. 6 in.		0 10 0
2 1¼ in. soldered joints	2/6	0 5 0
2 1¼ in. brass washer plugs and waste and soldered joint	8/6	0 17 0
54 ft. run ¾ in. lead pipe taken from 1¼ in. down service joints and fixing	1/1	2 18 6
2 ¾ in. branch joints	1/9	0 3 6
2 ¾ in. screw-down high-pressure horizontal bibcock (approved pattern), joint to lead pipe	8/9	0 17 6
Provide and fix draining board fixed under bottle rack, and line same with pewter, 2 ft. by 1 ft. 6 in.	31/-	1 11 0
Removal of lead sink **U** in housekeeper's room, make good and give credit	5/-	0 5 0
Provide and fix a small enamelled fireclay sink to cost 25/- fixed on proper tin-framed and wrought bearers	40/-	2 0 0
4 ft. run 1¼ in. lead waste to sink, carried through external wall to discharge over gully	1/4	0 5 4
1 1¼ lead syphon trap, with cleansing cap and screw, and joint to pipe and trap	8/9	0 8 9
1¼ in. lead anti-syphonage pipe carried through wall, with copper wire fixed on end of pipe, about 3 ft. ...	5/-	0 5 0
1 1¼ in. soldered joint	2/6	0 2 6
1 2½ in. brass grating and soldering to sink	3/-	0 3 0
16 ft. run, ¾ in. lead pipe as supply to sink	1/1	0 17 4
1 ¾ in. branch joint	1/9	0 1 9
1 ¾ in. screw-down high-pressure horizontal bibcock (approved pattern) and joint to lead pipe	8/9	0 8 9

Work to Bath.

Cut away ceiling and flat over bath-room and provide new skylight, cutting away part of box-room floor, and forming partitions with ventilating shaft, all as described in specification...		22 10 0
Remove the old bath **V** and its connexions and make good, and give credit at end of bill (except bath casing and lead safe)	25/-	1 5 0
Provide and fix a first quality cast iron enamelled bath 5 ft. 6 in. long	130/-	6 10 0
Allow for repairing and refixing lead safe to bath ...	9/-	0 9 0
22 ft. run, 1¼ in. lead overflow, carried under floor of back bed-room through external wall, including taking up, relaying flooring, and notching joists, if necessary	1/7	1 14 10
1 1¼ in. soldered joint	2/6	0 2 6
1 1¼ in. copper flap, and soldering to end of pipe ...	1/9	0 1 9

40 ft. run, 1½ in. lead waste to bath, joint and fixing with cast tacks	1/10	£3	13	4
Encase waste with asbestos	30/-	1	10	0
21 ft. run, 2 in. cast-iron drain pipe laid on 6 in. Portland cement concrete, joints caulked with lead, including digging average depth of 12 in., taking up flooring, relaying, and making all good	2/9	2	17	9
1 connection with 1½ in. lead pipe to 2 in. cast-iron drain pipes, and include for brass thimble and caulked metal joint and one end soldered joint at other	8/6	0	8	6
Provide and fix an improved copper waste with trap, and connect to bath	55/-	2	15	0
26 ft. run 1¼ in. lead ventilating pipe carried up in corner of air shaft and taken through flat 5 ft. above same	1/4	1	14	8
1 1¼ in. soldered joint	2/6	0	2	6
1 hole through lead flat, and soldering pipe to same	3/6	0	3	6
1 1¼ in. copper wire balloon and fixing on end of pipe	2/-	0	2	0
8 ft. run 1 in. lead supply to bath, including taking up flooring and relaying and matching joint if necessary	1/9	0	14	0
2 1 in. soldered joints	2/-	0	4	0
Provide and fix 1 in. plated overhanging screw-down taps to bath of approved pattern and fixing complete ...	23/-	2	6	0
Adapt and alter mahogany bath top and enclosure, make part of front to shift readily for easy access to fittings, &c.	45/-	2	5	0

Work in connexion with Hot Water.

Disconnect present hot-water pipes from kitchen boiler, and make good, and work in connexion	30/-	1	10	0
Provide and fix on strong iron bracket **H** a 50 gallon strong galvanised iron circulating cylinder	150/-	7	10	0
30 ft. run 1½ in. steam pipe flow and return from boiler to cylinder &c....	2/3	3	7	6
2 drillings in boiler and connexions	6/-	0	12	0
Drill hole in boiler, connect a short piece of pipe, fitted with a dead weight safety valve	32/-	1	12	0
2 connexions to cylinder	5/6	0	11	0
Provide and fix 1 in. gun metal stopcock, with square head and spanner, fixed above trap of cold water supply, and carry small branch of 1 in. pipe from cylinder, and fix a similar bibcock as draw off, with nozzle on end for fixing hose pipe	45/-	2	5	0
Connect up old 1 in. flow and return pipes to cylinder, with all necessary connexions	30/-	1	10	0
Encase hot-water cylinder with asbestos and leave inspection plate free	43/-	2	3	0
Fixing T-piece and elbow into main flow where it leaves cylinder to carry safety-valve, and provide and fix a dead weight	17/6	0	17	6
Remove old hot-water tank **AA** from bath room and make good to old connexion	12/6	0	12	6
22 ft. run, 1 in. steam pipe flow and return; take up to third-floor for supply to housemaid's sink	1/6	1	13	0
11 ft. run, 1 in. steam exhaust pipe carried up into roof and turned over into cistern in new dormer	1/6	0	16	6
Connecting of old hot-water pipe to new, say		0	5	0
8 ft. run, 1 in. steam supply pipe to bath, with all necessary connexions, including taking up flooring, relaying, and notching joists, as necessary	2/3	0	18	0

75 ft. run, ¾ in. do. as supply to housemaid's pantry and sinks	1/2	£4	7	6
14 ft. run, take up floor, notch joists	-/6	0	7	0
2 1 in. screw-down stopcocks fixed to hot and cold supplies under bath, with joints both ends	13/-	1	6	0
3 ¾ in. screw-down bibcocks (approved pattern) and connect to housemaid's sink and double sink in pantry ...	9/3	1	7	9
90 ft. run case hot-water pipes with asbestos where passing down casing alongside of other pipes	-/7	2	12	6

Drains.

Provide for the carrying off of rain water during the temporary removal of drains	20/-	1	0	0
592 ft. sup., take up stone paving, lay aside for re-use, and relay at completion and make good any deficiency with new, both for old and new drain	-/6	14	16	0
(NOTE.—This item will vary according to the character of the old stone floor.)				
148 ft. super. take up wood flooring and joists, cut same as may be necessary for the removal of old drains, and relay at completion and make all good	-/7	4	6	4
193 ft. run, dig, basket out, and cart away all old drains, together with wet and contaminated earth, and fill in all voids with lime and dry brick rubbish	1/9	16	17	9
Allow for removing any cesspool, catch pits, &c., that may be found, and fill in with lime and dry brick rubbish as before	50/-	2	10	0
Seal off old connexion with main drain in cement ...	5/-	0	5	0
51 ft. run, 4 in. strong cast-iron drain pipe coated with Dr. Angus Smith's solution, the joints caulked with lead laid on 6 in. Portland cement concrete, including digging, average depth 3 ft., filling in and ramming, remainder basketed and carted away	4/6	11	9	6
(NOTE.—This price will vary according to the nature of the ground and the amount of strutting required.)				
8 ft. run, 4 in. tested glazed stoneware pipes, the joints made with cement and sand, including laying on 6 in. of Portland cement concrete and covering with 6 in. of Portland cement concrete after drains are tested, including digging 2 ft. 6 in. deep, filling in and ramming, remainder basketed and carted away ...	3/9	1	10	0
4 ft. run, 6 in. tested glazed stoneware pipe, all as last, but digging 4 ft. deep	4/6	0	18	0
9 ft. run, 6 in. ditto, ditto, but deep digging, including any necessary planking and strutting from chamber to front vault	7/6	3	7	6
43 ft. run, 4 in. Doulton's tested pipes, all as first described, digging, average depth 2 ft. 6 in., and do. do.	3/9	8	1	3
2 extra only for 4 in. to 6 in. taper pipes	1/3	0	2	6
7 extra to 4 in. bends	1/3	0	8	9
2 extra to 6 in. bends	1/9	0	3	6
3 cut holes through 9 in. wall for 6 in. pipes and form arched eyes	4/-	0	12	0
2 ditto 14 in. ditto	6/3	0	12	6
1 ditto 22½ in. ditto	8/9	0	8	9
Give notice to vestry and pay fees for connecting new drain to main sewer	100/-	5	0	0
Provide and fix a 12 in. fat-trap flushing gully, with stone frame dished and rebated for iron cover	43/-	2	3	0

		£	s.	d.
32 ft. super. 2½ in. York paving, laid and pointed in mortar, to back area	2/-	£3	4	0
Provide and fix a 40 gallon automatic action galvanised iron flushing tank, with glass front, fixed on strong iron bracket, with ball valve, complete	126/-	6	6	0
9 ft. run, 2 in. lead flush pipe from flushing tank, soldered joint at one end and connected to flushing gully at the other	2/9	1	4	9
1 extra to bend	3/-	0	3	0
13 ft. run, ½ in. lead supply to flushing tank encased with felt, and secure with copper wire	1/2	0	15	2
2 ½ in. soldered joint	1/7	0	3	2
8 4 in. stoneware self-cleansing gullies set on concrete and connected to drain, gullies to have galvanised iron grids	8/9	3	10	0
Remove old brick dustbin, point and limewhite brickwork, and provide portable galvanised wrought iron dustbin	37/-	1	17	0

Inspection Chambers.

		£	s.	d.
Form two inspection chambers as described in specification, one in front area 3 ft. by 2 ft. 6 in. by 4 ft. deep. inside measurement, and one to middle area 3 ft. by 2 ft. by 2 ft. 6 in. deep, all as detail given below.				
6⅓ yards cube, excavate, basket out, and cart away surplus earth	7/6	2	7	6
5½ yards super. 6 in. Portland cement foundation ...	2/6	0	13	9
89 ft. super., one brick wall in cement	1/3	5	11	3
21 ft. run, labour, materials, corbelling over to receive air-tight covers...	1/-	1	1	0
10 yards super., render walls in Portland cement ...	3 -	1	10	0
2, form sloping benches in cement, and prepare concrete bottom to receive half channel pipes...	10/-	1	0	0
6 ft. run, 4 in. contracted outlet, white glazed channel pipe set in cement	2/6	0	15	0
8 4 in. white glazed channel curves	5/-	2	0	0
Provide and fix on proper cement concrete bed a syphon, with a 4 in. contracted inlet and 5 in. outlet, and connect on to outlet a 5 in to 6 in. socket	25/-	1	5	0
Allow for bedding stopper of inspection eye in grease	1/6	0	1	6
6 ft. run, 4 in. galvanised iron pipe at air inlet, including chase in brickwork rendered in cement, and short length of 4 in. drain-pipe and easy bend connected to inspection chamber	3/6	1	1	0
1 4 in. galvanised iron inlet valve and fixing on end of pipe	12/-	0	12	0
4 eyes formed in 1 brick wall for 4 in. iron pipe to pass through	3/-	0	12	0
8 ditto 4 in. stoneware ditto	3/-	1	4	0
4 connexions of white glazed channel to 4 in. iron drain-pipe	1/-	0	4	0
8 connexions of white glazed bend to 4 in. earthenware drain-pipe	1/-	0	8	0
2 approved galvanised air tight covers and frames and fixing complete	65/-	6	10	0
Allow for cutting away for and making good in all trades after all trades on the whole of the foregoing work not herein specified	400/-	20	0	0
		£638	3	10
Credit value of old materials		20	0	0
		£618	3	10

THE TERRACE HOUSE.

REPORT AND SUGGESTIONS ON EXAMPLE II.

73. *The Roof.*—This is principally of slate, with a lead flat over the staircase.

74. *Rain-water Pipe* **A** is of cast iron and 4 in. in diameter. It takes the water from the front gutter and is disconnected over a gully in the front area.

75. *Rain-water Pipe* **B** is also a 4 in. cast-iron pipe, and takes the bulk of the water. It passes on to the lead flat over the cistern and then down in a casing, where it delivers over a gully in the cupboard in the basement by the servants' hall.

Note A A.—The position of this gully in the cupboard is very undesirable. It is out of sight, and therefore not likely to be recharged, excepting in wet weather.

76. *Recommendation.*—This pipe had better be brought down on to the lead flat over the bath-room. In order to do this reverse the lead gutter on the flat over the cistern and fix about 8 ft. of 3½ in. galvanised cast-iron rain-water pipe, with head and shoe.

77. *Rain-water Pipe* **C**.—This is a similar pipe to **B**, but 2½ in. in diameter, and takes the water from the flat over the bath-room down on to the flat over the housekeeper's room.

78. *Recommendation.*—As this pipe will now have to take a much larger quantity of water than formerly, it must be changed for a galvanised cast-iron pipe 3½ in. diameter, with head and shoe (about 27 ft. run of pipe).

79. *Rain-water Pipe* **D** is a 4 in. cast-iron pipe and delivers the water from the flat over the housekeeper's room and larder into a disconnected gully in the back area.

80. *Recommendation.*—After removal of gully this pipe is connected with new drain to act as a ventilation to same. This drain delivers over gully **U** in middle area.

81. *Cistern* **E**.—This is a wood, lead-lined cistern, its inside measure being about 7 ft. by 3 ft. by 3 ft. 6 in. deep, and will hold about 400 gallons. It supplies everything,

both hot and cold water, with the exception of the butler's pantry sink **O**, the sinks in the servants' hall **P** and the housekeeper's room **Q**, also the w.c. marked **J** on plan. It does this by means of a 1¼ in. lead pipe carried down in the corner of the w.c.'s with branches to the several sinks. There is a trumpet-mouthed standing waste in this cistern, which is connected into the iron rain-water pipe **B** from the flat over.

82. *Recommendation.*—Construct a window 2 ft. by 1 ft. 6 in. in the external wall, fitted with louvres and wood shutters to light and ventilate the cisterns, and enclose the open end, after the removal of the w.c. partition, with double doors and frame up to the ceiling; divide the cistern, so that one side will hold about 150 gallons and the other about 240, with a wood partition made good with 6 lb. lead on one side, to be called "Cistern **E**." Supply a wrought-iron galvanised cistern as large as possible, and fix in the other compartment thus made after the removal of the old lead lining, which cistern will be called "Cistern **E**¹." Take out the old waste and make good to the bottom of the cistern after. Provide and fix two separate 1½ in. overflows from these cisterns, carried to deliver on to the flat over the bathroom; make good the existing down service into cistern **E**, and fix in same, immediately under the cistern, an inch screw-down high-pressure stopcock. This cistern will now supply the w.c.'s **G**, **H**, **I**, and **J** only. Provide a wooden lid to the cistern. The partition at the side of the w.c. **G** will be taken down and a fresh one constructed, as shown on amended plan, in order to break the connexion between the cistern enclosure and the w.c. (See Note G in first example.)

Reform w.c. **G** as shown on plan with new partition &c. The sides of this w.c. partition are to be plastered down to the floor on each before the skirting is fixed.

83. *Cistern* **E**¹.—Drill for, and connect with brass union, a 1¼ in. lead down service to the level of the basement ceiling, carry across the well of the staircase and down the casing to a point over the foot of the kitchen staircase. Provide and fix in same, under the cistern, a 1¼ in. screw-down high-pressure stopcock, and provide a wooden lid

84. *Cistern* **F**.—In the butler's room in the basement there is a zinc-lined wooden cistern in the cupboard to hold about 60 gallons. The waste from this empties over the top of the butler's sink. It supplies the sinks **O**, **P**, and **Q**, and w.c. **J**.

Note BB.—The first objection to this cistern is that it serves both the sinks and the w.c. (though this last is cut off by a flushing cistern). Another objection is that it is situated in a room used as a bedroom by the butler. This is very undesirable, both on account of those who have to drink water that has stood for many hours in such a position, and for the sake of the occupant of the room. The moisture in the air caused by evaporation from such a considerable surface of cold water in a warm room must certainly be detrimental to health.

The waste-pipe placed over the sink is another mistake. In the event of an overflow the chances are either that the plug would be in the sink, or that a sponge or tea leaves would be drawn into the outlet from the sink and prevent the escape of the waste water from the cistern, which would then flood the room.

85. *Recommendations.*—Remove this cistern, now no longer required. Provide and fix on brackets in w.c. **K**, in the front area, a shallow galvanised wrought-iron cistern, to hold 20 gallons, fixed close up to the ceiling, with a trapdoor in the roof of the w.c., under the iron staircase for access to same, and bring a 1¼ in. overflow pipe through the wall into the area.

86. *Main Supply.*—Remove the present large lead service pipes to the several cisterns, and carry up to one of the top cisterns a ¾ in. lead pipe, which, to be in order with the regulations of the water company, must not be of a less weight than 9 lb. per lineal yard. Fix in same in the scullery, near the point at which this main supply enters the premises, a ¾ in. high-pressure screw-down gun-metal stopcock. Carry a branch to the second top cistern, and one each to the flushing tank in the basement passage and w.c. cistern in the front area. Provide and fit to each branch a ¾ in. equilibrium ball valve. Cover the cistern that is to supply the w.c. in area, and also the exposed service pipes with hair felt, and enclose in wood case.

87. *Water-closet* **G**.—This closet is too near the cistern cupboard. It must be detached by an alteration in the position of the partition, as shown on the amended plan. (See par. 82.) The closet itself is one with a back wash-out, supplied by a disconnecting syphon cistern. It has a lead safe with a disconnected waste. There is a defect in the joint that connects the closet with the branch of the soil-pipe. (See note L in first example.)

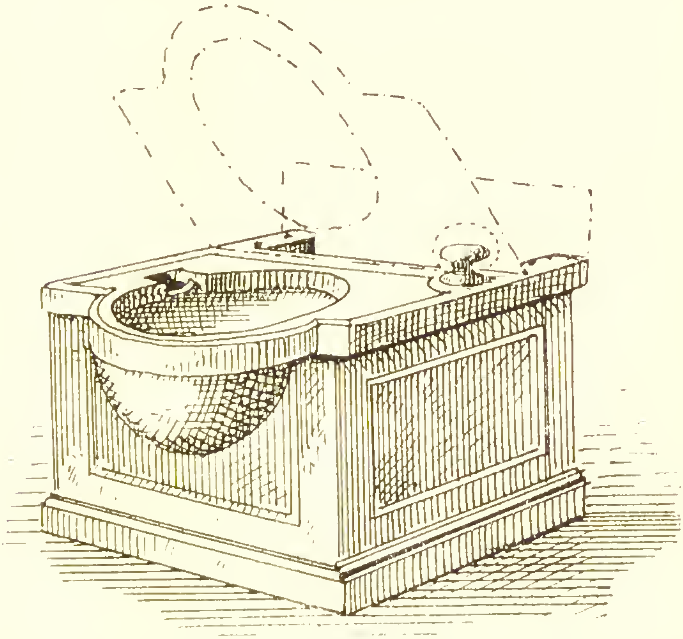
Note CC.—This closet has a glazed-ware P trap with flanged end and is bolted to a flanged lead out-go by means of an iron collar; the lead out-go is soldered to the soil-pipe. The strain of the bolts has broken the earthenware flange and caused the joint to become defective. There is also a provisional socket, A, on the outlet of the earthenware trap for an anti-syphonage pipe. (See illustration, par. 96.) This hole has been stopped up with a bung and white lead, which has become dry and loose, and this allows bad air from the soil-pipe to enter the house.

88. *Recommendations.*—A small hopper basin closet with flushing rim should be fixed here, fitted with an earthenware slop top, as described in recommendations for w.c. **J** in first plan, with supply from the old service, and trap and branch into the external soil-pipe, as there described.

89. Water-closet **H** is a valve closet of an inferior make, with a cast-iron valve box and overflow into the wrong side of same. (See note I in first example). The handle has not a parallel action. There is a lead safe under, with the overflow carried through the external wall. A cast-lead syphon trap is fixed under the closet, with a branch from same into the soil-pipe. It is supplied with water from cistern **E**.

90. *Recommendations.*—Use here an enclosed white earthenware pedestal valve closet. The one shown (Fig. 29) meets all the requirements of a valve closet, and the earthenware enclosure has the advantage of being readily accessible. Line the walls and the floor with tiles. For details see w.c.'s **J** and **K**, first example.

FIG. 29.



91. *Water-closet* **I.**—On the ground floor there is a side outlet closet with a weighted rubber-lined plunger attached to the handle and a supply valve under the seat. There is no safe under. The trap of the closet is cracked and will not hold water.

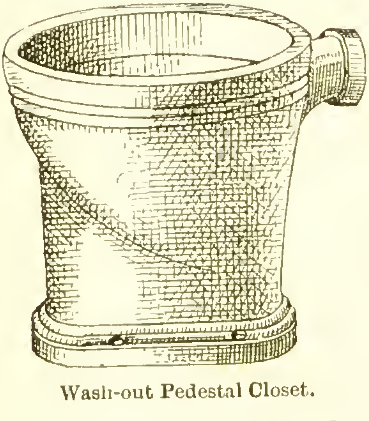
Note DD.—This closet is open to the same objections as all wash-out closets with the basin and trap in one piece of ware. (See note L in first example). In the case of this closet the evil of the side outlet is more pronounced, as the flush through the valve is less than that from a syphon cistern which is generally used, and the plunger also breaks the force of the water into the trap.

The crack in the trap is to be attributed to frost. The leakage from the trap was soon discovered in this case, as the water showed through the ceiling below. Had the closet been fixed on the ground-floor of a house some time might have elapsed before the escape of water would have been seen; meanwhile the bad air in the drain would have had free access to the house.

92. *Recommendation.*—Fix a similar closet here to the one described in par. 30, with a supply branch from the old down service, and the trap and branch to the external soil-pipe to be in all respects similar.

93. *Closet* **J** *(in basement).*—This is a wash-down pedestal one, with an S-trap under the centre of the square bottom (Fig. 30). When tested with a smoke rocket placed in the gully in the area this connexion was found to be defective. It is flushed by a galvanised wrought-iron two-gallon cistern, not syphonic.

FIG. 30.



Wash-out Pedestal Closet.

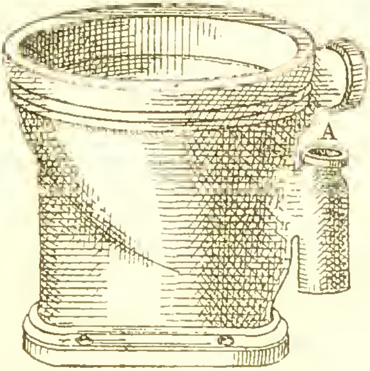
Note EE.—This closet is a good one if the outlet of the trap stands clear of, and not under the closet. (Figs. 30 and 31.) It is most difficult, and therefore risky, to make a joint between the trap and the drain with the outlet of the trap situated as this one is. The flushing tank only acts while the handle is held down, and the flush is quite inadequate.

94. *Recommendations.* — Use a closet as described for closet **N**, par. 32. Supply and fix at the back of the closet, 6 ft. 6 in. from the floor, a three gallon syphon silent-flushing cistern of cast iron, painted or galvanised, and connect a 1¼ in. down service from the same to the arm of the basin. See detail w.c. **N.**

95. *Water-closet* **K**.—This is a circular, stoneware, white-glazed, front-outlet closet with an independent S-trap under. The S-trap is fitted with an outlet for an anti-syphonage pipe, (see A, Fig. 31), which outlet is stopped with a cork and white lead. There is a two gallon flushing syphon-action cistern, which cistern is supplied from **E**. The closet is dirty, and there is a great inclination for the contents to hang in the basin. It has an enclosed fixed wood seat and riser.

96. *Recommendations.*—Provide a pedestal closet with flushing-rim basin and trap as described for closet **N**, par. 32, or a closet as illustrated (Fig. 31), but see that the joint to drain is at the back, above the floor line, where it can be easily made. The closet is made, and should be used without the provision for the anti-syphonage-pipe at A. This is shown here to illustrate Notes CC and EE, but it is undesirable, as it would seem impossible to make a permanent joint between earthenware and lead. The old cistern may be used again, and fix a new deal hinged seat on brackets and cement the wall under same.

FIG. 31.



97. *Soil-pipe.*—This is a 4 in. seamed lead pipe carried down inside the closets, where it enters the drain from the bottom closet; a 2 in. lead ventilator is continued up to about 2 ft. above the roof parapet wall. When a pailful of water was thrown down closet **G** the water in the trap of closet **H** was syphoned out below the seal. The effect on **G**

was also to reduce the water in the trap, but did not break the seal. The construction of the other closets prevented any observation of the traps.

Note F F.—The soil-pipe is insufficiently ventilated, and the connexion with the drain is made without the intervention of a brass thimble. (See Pars. 5 and 36 and Note O in first example.)

98. *Recommendations.*—After the removal of the old soil-pipe &c., fix in the external angle of the wall a 3½ in. drawn-lead soil-pipe, weight 10 lb. to the foot run, fixed with three pairs of stout cast-lead tacks to each 10 ft. length of pipe, properly nailed to the walls. Continue this pipe about 5 ft. above the top of the parapet wall, finished on the top with a perforated lead cap with copper wire-guard. Connect the branch soil-pipes from these upper closets and provide and solder on the bottom of the soil-pipe a strong brass thimble or sleeve piece for connexion with the iron branch of the drain. (See Pars. 5 and 36.) Drill a hole in the iron branch drain that connects the bottom closet to the manhole ; tap and screw into same a 2 in. brass union as near to the trap of the closet as possible. Take care that this union is not allowed to enter below the top of the drain, or if the socket A is retained to w.c. **J** (see Fig. 31) connect the anti-syphonage to same by a brass sleeve piece. Carry up from this union a 2 in. strong lead anti-syphonage pipe with branches from the traps of the other three closets. Connect the upper end of this pipe into the soil-pipe some 3 ft. above the branch from the top closet. (See anti-syphonage pipe in Par. 37 and following note O.)

99. *Sink* **L** (*on Third Floor*).—This is a lead-lined sink with syphon trap under and a 1¼ in. waste down into the drain at the foot of the kitchen stairs. There is a hot and cold supply.

Note G G.—This is an exposed and untidy place for a housemaid's sink. The waste pipe connexion direct with the drain is an additional and unnecessary opportunity for the introduction of bad air into the house ; in this case it is aggravated by the branch connexion from sink **M**, the trap of which is liable to syphonage when **L** is in use, as this waste pipe is without any ventilation.

100. *Recommendations.*—Remove the sink, waste, and services, and make good all works disturbed.

101. *Sink* **M**.—This is a lead-lined sink with a syphon trap under and a waste branched into the waste pipe of sink **L**. It has a hot and cold supply.

Note H H.—This sink is in its present position devoid of ventilation, enclosed as it is under the staircase, and a more suitable position must be found for it.

102. *Recommendations.*—Fix either a wood-framed or a lath-and-plaster partition in the bath-room, as shown on plan, to enclose the new sink-room ; cut away the lead flat over and put in new skylight, properly flashed &c., to light this room.

103. Remove the old lead-lined sink **M**, waste, and hot and cold-water service, and make good after. Provide and fix an enamelled fireclay sink in the new sink-room with 1½ in. stout lead waste, fitted with drawn-lead syphon trap (see Fig. 36), with brass inspection cap. Immediately under the sink connect a 1¼ in. anti-syphonage pipe on the out-go of the trap, carry through the external wall, and connect into the ventilating pipe of the waste, about 3 ft. up above the entrance of same. Continue the waste down to the middle area and connect by means of a brass sleeve piece directly into disconnected drain, delivering into gully **U**. Carry up this 1½ in. waste to 2 ft. above the parapet, to act as a ventilating pipe, and fit the end with double copper wires.

Carry a ¾ in. branch of lead pipe from the down service of cold-water cistern **E**¹ (see Pars. 82 and 83), and fix a ¾ in. screw-down bibcock to supply sink ; connect a ¾ in. branch from the hot-water flow-pipe to the bath, fitted with a similar bibcock. Carry a short ½ in. branch from rising main to supply this sink and provide and fix a ½ in. screw-down high-pressure bibcock. (See par. 123.)

Line the floor with 7 lb. lead, copper-nailed.

104. *Sink* **N** (*Scullery*).—This is a stone sink with 1½ in. waste into a brick-built fat-trap (See Note zi, first example) in the area. A drawn-lead syphon-trap is fixed under the sink and fitted with a screw-cap for inspection. The cold supply is from cistern **E**, and the hot from the hot-water system to the bath. (See Note Q in first example.)

105. *Recommendations.*—Remove the old stone sink and provide and fix in place of same a suitable stoneware glazed sink. Fix under the same a 2 in. drawn-lead syphon trap, with screw cap, and carry a strong lead 2-in. waste through the wall into the new flushing gully **BB** in the area. (See par. 69 and following note) Connect a 1½ in. anti-syphonage pipe on the out-go of the trap, and carry through the outer wall, finished fair with the face and fitted with a + copper wire guard in the end.

106. Provide and fix in the passage, outside the scullery, on strong iron brackets a 30 gallon galvanised wrought-iron automatic flushing tank **AA** ; carry a stout 2 in. lead pipe to discharge into the flushing gully **BB**, and supply the tank

by a ½ in. strong service from the main, fitted with a reverse action ball valve. Provide and fix a draining board at side of sink, covered with lead or pewter.

Continue a ¾ in. branch from the down service of Cistern **E**^{1} (see Pars. 82 and 83) in a lead pipe and fix to this and to the hot-water supply a screw-down high-pressure bibcock. Fix the stud partition **GG** with the door across the passage in order to keep back the smell of the scullery and kitchen.

107. *Sink* **O** *(butler's).*—This is a lead-lined, double sink with traps under and waste disconnected into the gully **X** in the area, and with hot and cold supply.

108. *Recommendations.*—Re-line the sinks with 6 lb. lead sides and 8 lb. bottoms and reconnect old wastes, but lengthen the end of same to deliver into the gully **X** in the altered position, and carry from the out-go of each trap a 1½ in. ventilating pipe through the wall into the area. Connect a ¾ in. lead branch pipe into the service to sinks **P** and **Q** from the main supply from cistern **E**^{1} (see Pars. 82 and 83) and fix horizontal, screw-down, high-pressure bibcocks to serve the sink. Provide and fix similar cocks for hot water, fix 1¼ in. brass washers and plugs and provide and fix draining boards as before. (See Note 8 in first example.)

109. A slate filter stands near this sink, with a separate supply from cistern **F**, and a service from the filter is fitted with a tap over the sink. All table-water is drawn from this tap.

Recommendation.—Remove and clear away connections.

Note 11.—Upon microscopic examination of this water it was found to contain living organisms. A neglected filter is infinitely worse than none at all. It only contaminates the water with accumulated filth.

110. *Sink* **P** *(Servants' Hall).*—This is a lead-lined sink with a 1 in. waste pipe into the gully **T** in the area, fitted with a drawn-lead syphon trap and supplied with hot and cold water, the latter from cistern **F**.

111. *Recommendations.*—Re-line the sink with 6 lb. lead sides and a 8 lb. bottom. Carry a 1½ in. strong lead waste-pipe into the new gully **T** in the area, fitted with trap and air-pipe, as before described. Continue from the bottom of the down service from cistern **E**^{1} an inch lead pipe on the ceiling line as far as this sink, with a short ¾ in. branch to supply same, fitted with screw-down tap, as to **O**, also for hot-water service, and with a new 2½ in. brass grate in the bottom.

112. *Sink* **Q** *(Housekeeper's Room).*—This is a lead-lined sink with disconnected waste into the external gully **S**, not trapped, and with hot and cold supplies as the last one, (See Note T in first example.)

113. *Recommendations.*—Fix a fireclay enamelled sink in place of the lead one with 1¼ in. lead waste properly trapped (see sink **O**) and carried into the external gully **S** in the back area. Continue the ¾ in. service from **P** and fit hot and cold taps, as before described.

114. *Bath* **R** *and Hot Water System.*—There is an old painted zinc bath enclosed in mahogany casing, with top; also a plug and chain waste, which is carried through the external wall and delivers over a rain-water head inserted in the pipe that takes the water from the flat over. A lead safe under the bath has an overflow pipe carried through the external wall.

The hot and cold supplies are delivered over the foot of the bath by bibcocks, the cold supply from cistern **E**.

The hot-water cistern is fixed on the floor in the cupboard under cistern **E**; the expansion pipe is turned over this cistern and is fed by means of a small supply cistern fixed at the side of same, with a trapped service into the return pipe to the kitchen boiler, the 1 in. flow and return pipes from which are carried up the same casing as the rain-water pipe **B**.

There is no safety-valve to the kitchen boiler.

Note JJ.—The waste into the rain-water head is a mistake. The soapy water from the bath will corrode the long gutter on the flat over the housekeeper's room, and cause annoyance by the smell which is sure to arise The cold supply pipe has been brought over the top of the safe in such a way that the leaky valve has allowed the water to tail back down the pipe and fall outside the safe instead of into it, thereby doing much damage to the school-room ceiling.

115. *Recommendations.*—Provide and fix a 5 ft. 6 in. cast-iron, white-enamelled, parallel bath, with a running 1½ in. lead trap under same, fitted with brass inspection-cap and screw. Connect to bath with brass-plated grate and union, the grate to be fitted with a vulcanite plug and brass chain. Carry a 1½ in. lead waste from out-go of trap into waste from sink **M**, and an anti-syphonage pipe into the ventilating pipe from same. Provide a plated brass grate and brass union as overflow to bath, and carry a 1½ in. short lead pipe through outer wall, fitted at end with a copper draught check. Repair and refix the lead safe and carry a 1¼ in. overflow through the wall as before. (See also Par. 51.)

Connect the present cold-water service into the new down service from cistern **E**^{1} and provide two proper plated, screw-down bath taps, and fix on hot and cold supplies. Alter the cold service under the bath tap so that any leakage will fall into the safe. The cocks to be overhanging, plated ones, as described in par. 51. Adapt mahogany casing and refix same.

Remove the small supply-cistern at the side of the closed hot-water tank and stop off connexions.

Provide and fix, on strong iron brackets at the side of the kitchen, a 56 gallon galvanised iron hot-water cylinder **FF** (see illustration, par. 53) with 1½ in. flow and return pipes from same to the boiler. Disconnect the pipes from the old boiler and connect to top and bottom of the cylinder. Connect a 1 in. branch lead pipe from the service to the scullery; form a deep trap in same and connect into the return pipe from the cylinder into the boiler. Provide and fix in same a square-headed, screw-down stopcock and spanner (the key of which should be kept by some responsible person), also a square-headed, draw-off bibcock, with a ¾ in. lead pipe carried over gully **A** in front area, for emptying the cylinder. Provide and fix, on top of the boiler, a 1 in. dead-weight safety valve. This to be fixed on end of 1¼ in. pipe carried through chimney breast to kitchen (see par. 53). Enclose the cylinder with asbestos.

116. *The Drains.*—The drains have been comparatively recently and carefully laid, but several errors have been committed, both in arrangement and execution, that have nullified their utility. Both are 6 in. glazed earthenware pipe drains, not town-made. There is a well-built disconnecting chamber **AA** in the scullery with a hinged iron cover, but with a broken lock.

117. *Front Area.*—There is a main branch from the w.c. **K** to the disconnecting chamber, with branches from the rain-water pipe **A** and the centre gully **Y**, also from the fat-trap **Z** (see Par. zi., first example). There is an inlet air ventilator to the chamber, the talc valve to which has one hinge broken and is partially stopped by dead flies and dust.

An inspection chamber **W** by the door to the servants' hall collects the several branches, as shown on plan. It was found impossible to fill them with water.

Note K K.—The first objection to this plan is that there is so little ventilation to the drain; the 2 in. pipe carried up from the top of the soil-pipe is quite insufficient when the diameter of the drains is considered. (See Note z ii. in first example.)

Another great objection is the position of the two chambers inside the house. Other weak points are (1) the position of the gully in the cupboard (see Par. 75 and Note AA); (2) the two long lengths of unventilated drain laid under the servants' hall and housekeeper's room; (3) the direct connexion of the sink waste at the foot of the stairs with the main drain (this should have been brought out to the nearest area and made to deliver over a gully). So much for the objections to the plan; now for the defects in execution. The use of earthenware in place of town-made stoneware pipes should not be resorted to on account of economy without the exercise of great care in the selection of each individual pipe. Earthenware pipes are made of some one local clay, few of which will stand the heat necessary to thoroughly vitrify them without distortion of the pipe; nor are they so smooth as the town-made ones. These last are compounded of mixed clays, generally broken burnt clays mixed together; they are capable of standing a great heat and receive a high glaze. It is of considerable importance to select pipes of good shape, as unless this is done it is impossible to lay a drain with equal fall and an even bottom. The advantage of a high glaze is obvious.

The drains, though laid on concrete, are not filled in all round with the same, and the result of this omission would be that each pipe could only rest directly on the collar. The other end would bear upon the collar of its neighbour, with an inclination to squeeze the new cement in the joint out at the bottom and allow the inner edge of the next pipe to stand up in front of it. This would not only render the bottom of the drain uneven and check the flow of the water, but when the earth was thrown into the trench and rammed many of these joints would be broken.

118. *Recommendations.*—Build a disconnecting chamber **Z** in the front area, as shown on plan and described in report of Example No. 1, par. 67, and Note ZII.

Build an inspection chamber **W** in the middle area, as before described.

The main drain from chamber to chamber should be laid with 4 in. heavy cast-iron pipe, treated internally with Dr. Angus Smith's solution, and also the length of drain from soil-pipe to manhole, so that the soil-pipe may be easily tested at any future time by inserting a drain-stopper.

The drains from back area are to be 4 in. stoneware pipe drains laid as before described, and are to be disconnected to deliver into a gully **U** in middle area. This drain will be ventilated by the rain-water pipe **D** from lead flat over housekeeper's room which does not deliver over a gully but is directly connected. Par. 80.

Remove the old brick-built dustbin and point and limewhite behind same. Provide a portable galvanised wrought-iron bin.

Note LL.—Should a larger main drain be used than 4 in., the following should be done. Build a small inspection chamber in back area, and carry a 5 in. iron drain from this into chamber in middle area. Disconnect rain-water pipe and bath wastes over gullies, and carry up a 4 in. ventilating pipe to some 3 ft. above lead flat over bath-room, either in 8 lb. lead soil-pipe or in stout galvanised iron with leaded caulked joints.

ESTIMATE

For proposed Alterations and Sanitary Work as explained in Specification and shown on Plans. (EXAMPLE II.)

Work in connexion with the Rain-water Pipes.

		£	s.	d.
Forming opening for new outlet **B**, dress lead so as to deliver over rain water head, and provide any new lead that may be required; remove old pipe and make good	25/-	1	5	0
8 ft. run, 3¼ in. galvanised cast iron rain-water pipe, and fixing from outlet to flat over bath-room	1/4	0	10	8
1 3½ in. head	3/6	0	3	6
1 3½ in. shoe	1/10	0	1	10
27 ft. run, 3½ in. galvanised cast iron pipe **C**, from flat, over bath-room to flat over housekeeper's room... ...	1/4	1	16	0
1 3½ in. head	3/6	0	3	6
1 3½ in. shoe	1/10	0	1	10
Remove old rain-water pipe and make good	12/6	0	12	6
Connect rain-water pipe **D** to drain with short length of pipe	6/-	0	6	0

Work in connexion with Cisterns.

Cut opening through 9 in. wall 2 ft. by 1 ft. 6 in., make good jamb and provide and fix in same a framed louvre light and shutters	40/-	2	0	0
Take down partition and clear away	5/-	0	5	0
57 ft. super. 1½ in. deal square framing as enclosure to cistern room	1/6	4	5	6
No. 2 extra, to forming and hanging doors in same, hung with butts and fitted with proper fastenings ...	7/6	0	15	0
10 ft. 6 in. super., 1½ in. deal division to cistern, housed to present sides	1/6	0	15	9
Remove old lead lining cistern **E** from one compartment and make good and give credit	6/6	0	6	6
2 qr. 10 lb. 6 lb. lead lining to division	25/-	0	14	9
6 ft. run, soldered seam	1/6	0	9	0
3 ft. 6 in. run, close copper nailing...	-/3	0	0	10
Supply and fix in other compartment of cistern **E** a 240 gallon galvanised iron cistern **E**^{1}	156/-	7	16	0
6 ft. run, 1½ in. lead overflow to both cisterns	1/8	0	10	0
2 1½ in. brass unions and joint	8/9	0	17	6
2 holes in lead-lined cistern and galvanised cistern ...	1/6	0	3	0
Make good the existing down service	12/6	0	12	6
1 1 in. screw-down high-pressure stopcock with unions and soldered joints both ends	18/6	0	18	6
1 ¾ in. deal ledged cistern-cover and frame, hung with and including 1 pair cross garnets, and paint same four oils	17/6	0	17	6
Remove partition to w.c. **G** third floor and clear away	5/-	0	5	0
59 ft. super., stud partition to form new w.c., lath and plaster flat and set both sides	1/1	3	3	11
16 ft. 6 in. super., 1½ in. square framed door, with linings complete, and paint 4 oils	2/2	1	15	9

1 proper w.c. catch and furniture	3/6	£0	3	6
1 4 in. brass barrel bolt	1/6	0	1	6
1 pair 4 in. butt screw and hanging	1/6	0	1	6
5 ft. run, deal skirting to match existing	1/-	0	5	0
55 ft. 1¼ in. lead service from cistern **E**^{1} to basement ceiling	1/5	3	17	11
1 1¼ in. brass union hole drilled in cistern and joint	8/3	0	8	3
1 1¼ in. screw-down high-pressure stopcock, with union and soldered joints both ends	26/0	1	6	0
1 ¾ in. deal ledged cistern cover and frame, bung with and including 1 pair cross gannell and paint 4 oils	17/6	0	17	6
Remove the cistern **F** in butler's pantry and make good	5/-	0	5	0
Provide and fix in w.c. **K** 20 gallon galvanised iron cistern fixed on strong brackets	32/-	1	12	0
1 trim for and provide and fix small trap door in roof of w.c. for access to cistern	20/-	1	0	0
2 ft. run, 1¼ in. lead overflow to cistern	1/4	0	2	8
1 1¼ in. brass union hole drilled in cistern and joint	8/3	0	8	3
Remove the present large lead service pipes, make good, and give credit at end of bill	25/-	1	5	0
93 ft. run, ¾ in. lead main supply to cistern	1/1	5	6	2
37 ft. run, ¾ in. branches to cistern **S**	1/1	2	0	1
1 ¾ in. screw-down stopcock, with union and joints both ends	13/9	0	13	9
3 ¾ in. equilibrium ball valves	8/9	1	6	3
3 ¾ in. brass union holes drilled in cistern and joints	5/9	0	17	3
4 ¾ in. branch joints	1/9	0	7	0
44 ft. run, take down deal casing and refix with brass cups and screws	-/6	1	2	0
32 ft. run, encase supply pipes passing from scullery to cistern in front area with felt secured with copper wire	-/6	0	16	0

Work in connexion with Water-closets.

Clear away the closet **G** on third floor and make good all work disturbed	17/-	0	17	0
1 4 lb lead safe under closet, about ½ cwt.	12/-	0	12	0
3 ft. run, labor dressing over fillet, including copper nailing	-/4	0	1	0
3 ft. run, 1½ in. by in. deal fillet	-/2	0	0	6
1 ft. 6 in. run, 1 in. lead waste pipe from safe, carried through external wall	1/2	0	1	9
1 1 in. copper flap and soldering	1/6	0	1	6
1 1 in. soldered joint lead pipe to safe	2/-	0	2	0
Provide and fix in position a short hopper with flushing rim and slop top supported on pedestals with 8 lb. lead syphon trap, and including hinged seat and brackets complete	90/-	4	10	0
1 galvanised 3 gallon syphon silent water waste preventer, with brackets, pull, and chain	37/6	1	17	6
5 ft. run, 1¼ in. lead flush pipe from water-waste preventer to closet, including joint and fixing with cast lead tacks soldered to pipe	1/5	0	7	1
2 soldered joints	2/6	0	5	0
2 ft. run, ½ in. lead supply to water-waste preventer	-/9	0	1	6
2 ½ in. soldered joints	1/7	0	3	2
1 ¾ in. soldered joints	1/9	0	1	9
1 ½ in. screw-down stopcock, with unions and joint both ends	9/6	0	9	6

1 ft. 9 in. run, ¾ in. lead overflow from water-waste preventer carried through external wall	1/1	£0	1	11
1 lead **P.** trap and joint to hopper	16/-	0	16	0
Fix branch of 3½ in. 10 lb. lead bent pipe 11 ft. long, carried through external wall and soldered at one end to lead trap and the other to soil pipe	55/-	2	15	0
Clear away old closet **H** on second floor and make good all work disturbed	20/-	1	0	0
21 ft. super., take up flooring, put sound boarding, and lime and hair pugging, as taken in Estimate I. to w.c. **K**	-/8	0	14	0
2⅓ yards super., provide and lay tile floor, P.C., 12/- per yard, and include for Portland cement floated surface...	21/-	2	9	0
17¾ yards super., prepare, match, and mend in cement, provide and fix white glazed tiles, P.C., 10/- per yard, as taken in Estimate I., to w.c. **K**...	19/-	16	17	3
Provide and fix a pedestal valve closet, flushing rim basin and table top in earthenware, also with earthenware valve box and enclosure to closet 1¼ in. valve copper regulator, mahogany seat in position as shown on plan, with 1¼ in. ventilation pipe	270/-	13	10	0
3 ft. run, 1½ in. lead ventilating pipe from valve-box carried through external wall	1/8	0	5	0
1 1½ in. soldered lead joint	2/10	0	2	10
8 ft. 6 in. run, 1¼ in. lead flush pipe to w.c.	1/4	0	11	4
2 1¼ in. joints	2/6	0	5	0
1 1¼ in. screw-down stopcock and soldered joints and union at each end	26/-	1	6	0
1 3½ in. lead P trap, with soldered joint and fixing to closet	16/-	0	16	0
1 short branch of 3½ in. 10 lb. lead bent pipe, about 2 ft. 6 in. long, with soldered joint at one end to trap, at the other to soil pipe	25/-	1	5	0
Allow for lead safe under valve closet	10/-	0	10	0
3 ft. 6 in. run, 1¼ in. lead waste from safe carried through external wall	1/4	0	4	8
1 1 in. copper flap soldering	1/6	0	1	6
1 1¼ in. soldered joint to safe	2/6	0	2	6
Remove the old closet **I** on ground floor, and make good all work disturbed.	20/-	1	0	0
14 ft. run, take up flooring, lay sound boarding, lime and hair plugging	-/8	0	9	4
1¾ yds. Provide and lay tile floor p.c. 12/- per yard, and include for Portland cement floated surface ...	21/-	1	16	9
Provide and fix a pedestal closet with 8 lb. lead syphon trap, white basin, mahogany flap, paper box complete	120/-	6	0	0
1 short branch of 3½ in. 10 lb. lead bent pipe, about 40 in. long, connected at one end with brass thimble-piece and soldered at other end to soil pipe	40/-	2	0	0
1 3 gallon syphon silent water-waste preventer, with bracket and plated chain and pull	50/-	2	10	0
6 ft. run, 1¼ in. lead flush pipe from water-waste preventer to closet and fixing with cast lead tacks	1/10	0	11	0
2 soldered joints to pipe	2/6	0	5	0
5 ft. run, ½ in. lead supply to water-waste preventer...	-/9	0	3	9
1 ft. 6 in. run, ¾ in. lead overflow	1/1	0	1	8
2 ½ in. soldered branch joints	1/7	0	3	2
1 ¾ in. soldered branch joint...	1/9	0	1	9
Remove the old wash-down closet **J** and make good	12/6	0	12	6
Provide and fix a pedestal closet with flushing rim properly fixed, refix the old deal hinged flap ...	40/-	2	0	0

1 3 gallon syphon flushing water-waste preventer, with brackets, chain, and pull	37/6	£1	17	6
5 ft. run, 1¼ in. lead flush pipe from water-waste preventer to closet, with cast tacks soldered to lead pipe	1/10	0	9	2
2 soldered joints to do.	2/6	0	5	0
5 ft. run, ½ in. lead supply to water-waste preventer	/9	0	3	9
1 ft. 6 in. run, ¾ in. lead overflow	1/1	0	1	8
2 ½ in. soldered joints	1/7	0	3	2
1 ¾ in. soldered joint	1/9	0	1	9
Remove the old closet **K** in front area, and make good	12/6	0	12	6
Provide and fix a pedestal closet with flushing rim and properly fixed, refix deal seat and riser, but hinge seat	40/-	2	0	0
Refix the old water-waste preventer	3/6	0	3	6
5 ft. run, 1¼ in. lead flush pipe from water-waste preventer to closet with cast tacks soldered to lead pipe	1/10	0	9	2
2 soldered joints	2/6	0	5	0
1 ft. 6 in. run, ¾ in. lead overflow	1/1	0	1	8
7 ft. run, ½ in. lead supply from cistern to water-waste preventer	/9	0	5	3
2 ½ in. soldered joints	1/7	0	3	2
1 ¾ in. soldered joint	1/9	0	1	9
1 ½ in. brass union hole drilled in cistern and joint	5/6	0	5	6
Remove the whole of soil-pipe at back, make good, and give credit at end of bill	12/6	0	12	6
60 ft. run, 3½ in. 10 lb. lead soil pipe fixed at back of house, with all necessary joints, and cast lead tacks soldered to pipe, carried up 5 ft. above parapet	5/4	16	0	0
Connect soil-pipe to iron drain **V** with easy bend and brass thimble and soldered joint	12/6	0	12	6
1 3½ in. copper wire balloon fixed on top of soil-pipe	3/-	0	3	0
Drill hole in iron branch, drain and fix a 2 in. brass union with joint to lead pipe	15/-	0	15	0
62 ft. run, 2 in. lead anti-syphonage pipe carried up alongside soil-pipe, with all necessary joints, and cast tacks, soldered to pipe	2/6	7	15	0
7 2 in. branch soldered joints	3/4	1	3	4

Work in connexion with Sinks.

Remove the sink **L** on third floor under staircase and make all good and give credit	10/-	0	10	0
80 ft. super., stud partition **M**, lath, plaster, float, and set, both sides to form new enclosure to sink in bath-room	1/1	4	6	8
19 ft. super., 1¾ in. moulded (both sides) door, with linings and architraves complete	2/2	2	1	2
1 pair 4 in. butts, screws and fixing	1/6	0	1	6
1 6 in. mortice lock and brass furniture	8/-	0	8	0
Take down present door &c. to bath-room and refix in new partition complete, and make all good	7/6	0	7	6
23 ft. run, plaster moulded cornice to match that in bath-room	2/3	2	11	9
17 ft. run, deal moulded mitred skirting to match existing	1/-	0	17	0
Allow for cutting away lead flat over, trim for and fix 2 in. skylight, with curb, properly flashed, and glaze with ⅛ in. Hartley's rolled glass, and make good all work disturbed 2 ft. 6 in. by 2 ft.	80/-	4	0	0

Remove old lead lined sink, with its connexions, and make good and give credit at end of bill for old materials	10/-	£0	10	0
Provide and fix a fireclay enamelled sink, fixed on strong brackets, 36 in. by 22 in. by 10 in.	60/-	3	0	0
42 ft. run, 1½ in. strong lead waste, carried through external wall and down to middle area, to discharge into side inlet of gully	1/9	3	13	6
20 ft. run, 1½ in. strong lead pipe to ditto, carried up as ventilating pipe 2 ft. above parapet	1/9	1	15	0
1 1½ in. lead syphon trap, with cleansing cup and screw and joint to pipe	10/-	0	10	0
4 ft. 6 in. run, 1½ in. lead anti-syphonage pipe, fixed on outgo of trap and carried through external wall...	1/8	0	7	6
1 hole through lead flat, with soldered joint to pipe passing through	5/-	0	5	0
4 1½ in. soldered joints	2/10	0	11	4
1 1½ in. copper wire balloon and fixing	2/0	0	2	0
21 ft. run, ¾ in. lead supply	1/1	1	2	9
2 ¾ in. branch joints	1/9	0	3	6
14 ft. run, ¾ in. steam-pipe as hot supply, with connexion from bath and sink	1/2	0	16	4
25 ft. ½ in. stout lead service	-/9	0	18	9
1 ½ in. high-pressure screw-down bibcock	4/10	0	4	10
2 ½ in. soldered joints	1/7	0	3	2
32 ft. run, take up flooring and relay and notch joists if necessary	-/6	0	16	0
2 ¾ in. screw-down bibcocks, hot and cold (approved pattern), and joints	9/3	0	18	6
3 qr. 3lb. 7 lb. lead and laying on floor	22/6	0	17	5
21 ft. run, close copper nailing	-/3	0	5	3
Remove the old stone sink **N** in scullery, and make good	5/-	0	5	0
Provide and fix a glazed earthenware sink 48 in. by 24 in. by 6 in., fixed on half-brick bearers and rendered with Portland cement	70/-	3	10	0
3 ft. run, 2 in. lead waste carried through external wall to discharge into flushing gully	2/6	0	7	6
1 2 in. lead syphon trap with cleansing cap and screw with soldered joint to pipe and trap	12/6	0	12	6
1 1¼ in. anti-syphonage pipe carried through external wall and copper wire fixed on end of pipe, about 1 ft. 6 in.	3/6	0	3	6
1 1¼ in. soldered joint	2/6	0	2	6
Provide and fix a 40 gallon automatic action galvanised iron flushing tank **AA** with glass front, fixed on strong iron brackets, with ball valve complete	126/-	6	6	0
16 ft. run, 2 in. lead flush pipe from flushing tank soldered at one end and continued underground and connected to flushing gully at the other end	2/9	2	4	0
1 extra to bend	3/-	0	3	0
2 ft. run, ½ in. lead supply to flushing tank	-/9	0	1	6
2 ½ in. soldered joints	1/7	0	3	2
38 ft. run, ¾ in. lead supply to scullery sink	1/1	2	1	2
1 ¾ in. branch joint	1/9	0	1	9
1 ¾ in. screw-down high-pressure bibcock (approved pattern), and joint to lead pipe	9/3	0	9	3
1 ¾ in. screw-down do., and joint to iron pipe	9/3	0	9	3
Provide and fix draining board covered with pewter, fixed under plate rack, 2 ft. by 1 ft. 6 in.	31/-	1	11	0
26 ft. super., stud partition **GG**, lath, plaster, float, and set both sides across passage as shown on plan ...	1/1	1	8	2

19 ft. super., 1½ in. square framed door with linings complete, and paint 4 oils	2/2	£2	1	2
1 pair 4 in. butts, screws, and fixing	1/6	0	1	6
1 6 in. rim lock and brass furniture	5/6	0	5	6
5 ft. run, 1 in. deal square skirting, paint four oils ...	-/8	0	3	4
Allow for stripping lead from old sink **O** in butler's pantry, and give credit	3/-	0	3	0
1 cwt. 8 lb. milled lead in re-lining sink in butler's pantry	25/-	1	6	9
8 ft. run, soldered seam	1/6	0	12	0
11 ft. run, close copper nailing	-/3	0	2	9
5 ft. run, 1¼ in. lead waste connected to old waste and taken into side inlet of gully	1/4	0	6	8
2 1¼ in. soldered joints...	2/6	0	5	0
1 1¼ in. lead anti-syphonage pipe carried through external wall, with copper wire fixed on end of pipe ...	10/-	0	10	0
2 1¼ in. soldered joints	2/6	0	5	0
2 1¼ in. brass washers, plug and waste, and soldered joint	8/6	0	17	0
40 ft. run, 1 in. lead pipe taken from 1¼ in. down service carried along ceiling as far as sink to servants' hall to supply three sinks	1/3	2	10	0
1 1 in. soldered joint	2/-	0	2	0
2 extra to bends in 1 in. lead pipe	1/-	0	2	0
17 ft. run, ¾ in. lead supply to butler's sink taken from 1 in. branch	1/1	0	18	5
1 ¾ in. soldered joint	1/9	0	1	9
2 ¾ in. screw-down, high-pressure, horizontal bibcocks (approved pattern), and joints to lead pipe... ...	9/3	0	18	6
2 ¾ in. do., do., and joints to iron pipe	9/3	0	18	6
Provide and fix draining board fixed under bottle rack and line same with pewter, 2 ft. by 1 ft. 6 in.	31/-	1	11	0
Remove filter and make good work disturbed	5/-	0	5	0
Allow for stripping lead from old sink **P** in servants' hall and give credit at end of bill, size 2 ft. 6 in. by 1 ft. 6 in. by 1 ft.	3/-	0	3	0
3 qr. 2 lb. milled lead in re-lining sink	25/-	0	19	3
4 ft. run, soldered seam	1/6	0	6	0
8 ft. run, close copper nailing	-/3	0	2	0
7 ft. run, 1½ in. strong lead waste pipe carried through external wall into gully	1/9	0	12	3
1 1½ in. lead syphon trap, with cleansing cap and screw and joint to pipe and trap	10/-	0	10	0
1 1¼ in. lead anti-syphonage pipe carried through wall, with copper wire fixed on end of pipe	7/6	0	7	6
1 1¼ in. soldered joint...	2/2	0	2	2
1 2½ in. brass grating and soldering to sink	3/-	0	3	0
12 ft. run, ¾ in. lead pipe as supply to sink	1/1	0	13	0
1 ¾ in. branch joint	1/9	0	1	9
1 ¾ in. screw-down high-pressure horizontal bibcock (approved pattern), and joint to lead pipe	9/3	0	9	3
1 ¾ in. do. for hot water, and joint to iron pipe ...	9/3	0	9	3
Remove the old sink **Q** with its connexions in housekeeper's room, and give credit and make good	5/-	0	5	0
Provide and fix a small enamelled fireclay sink fixed on proper fir-framed and wrought bearers	31/-	1	11	0
7 ft. run, 1¼ in. lead waste, carried through external wall to discharge over gully	1/4	0	9	4
1 1¼ in. lead syphon trap with cleansing cap and screw, and joint to pipe and trap	9/-	0	9	0
1 1¼ in. lead anti-syphonage pipe carried through wall with copper wire fixed on end of pipo	7/6	0	7	6

1 1¼ in. soldered joint	2/-	£0	2	0
1 2½ in. brass grating, and soldering to sink	3/-	0	3	0
12 ft. run, ¾ in. lead supply to sink	1/1	0	13	0
1 ¾ in. branch joint	1/9	0	1	9
1 ¾ in. screw-down high-pressure horizontal bibcock (approved pattern) and joint to lead pipe	9/3	0	9	3
1 ¾ in. ditto, but joint to iron pipe	9/3	0	9	3

Work to Bath.

Disconnect supplies to bath **R** and clear away bath and lay aside lead safe for re-use	20/-	1	0	0
Remove hot-water cistern and its connexion and also small supply cistern and make good works disturbed ...	12/6	0	12	6
Provide and fix a first quality cast-iron enamelled bath 5 ft. 6 in. long	130/-	6	10	0
Allow for repairing and re-fixing lead safe to bath ...	10/-	0	10	0
2 ft. run, 1¼ in. lead overflow carried through external wall	1/4	0	2	8
1 1¼ in. soldered joint	2/6	0	2	6
1 1¼ in. copper flap, and soldering to end of pipe ...	1/6	0	1	6
16 ft. run, 1½ in. lead waste connected into sink waste	1/8	1	6	8
2 1½ in. soldered joints	2/10	0	5	8
1 1¼ in. lead anti-syphonage pipe connected into ventilating pipe	7/6	0	7	6
2 1¼ in. soldered joint	2/6	0	5	0
Provide and fix a copper waste with trap, and connect to bath	55/-	2	15	0
Allow for connecting up old hot and cold supplies ...	15/-	0	15	0
Provide and fix 1 in. plated overhanging screw-down taps to bath (approved pattern) and fixing complete ...	23/-	2	6	0
Alter cold service under bath tap that any leakage will fall into safe	5/-	0	5	0
Adapt and alter mahogany bath top and enclosures, and make part of front to shift readily for easy access to fitting	45/-	2	5	0
Disconnect present hot-water pipes from kitchen boiler, and make good	10/-	0	10	0
Provide and fix on strong iron bracket a 50 gallon strong galvanised iron circulating cylinder **FF**	150/-	7	10	0
30 ft. run, 1½ in. steam pipe flow, and return from boiler to cylinder &c.	2/3	3	7	6
2 drillings in boiler and all necessary connexion ...	6/-	0	12	0
2 connexions to cylinders	5/6	0	11	0
Provide and fix 1 in. gun-metal stopcock with square head and spanner fixed above trap of cold-water supply, and carry small branch of 1 in. pipe from cylinder and fix a similar bibcock, and draw off with nozzle an end for fixing hose if required	45/-	2	5	0
Connect up old 1 in. flow and return pipes to cylinder, with all necessary unions, back nut, &c.	10/-	0	10	0
Encase hot-water cyclinder with asbestos and leave inspection plate free	43/-	2	3	0
Drilling hole in boiler and providing and fixing a dead-weight safety valve on end of 1¼ in. pipe, and brought through chimney breast	32/-	1	12	0

Work to Drains.

Provide for the carrying off of rain-water during the temporary removal of drains	20/-	£1	0	0
469 ft. super. Take up stone paving, lay aside for re-use, and relay at completion, and make good any deficiency with new	-/6	11	14	6
(NOTE.—This item will vary according to the conditions of the old floor.)				
132 ft. super. Take up wood flooring and joists, cut same as may be necessary for the removal of old drain, and relay at completion and make all good	-/7	3	17	0
159 ft. run, dig, basket out, and cart away old drain, together with wet and contaminated earth, fill in all voids with lime and dry brick rubbish	1/9	13	18	3
Allow for removing any cesspools, catch-pits, &c., that may be found, and fill in with lime and dry brick rubbish as before	50/-	2	10	0
Seal off old connexion with main drain in cement ...	5/-	0	5	0
49 ft. run, 4 in. strong cast-iron drain pipe coated with Dr. Angus Smith's solution, the joints caulked with lead laid on 6 in. Portland cement concrete, including digging, average depth 3 ft., filling in and ramming remainder, basketed, and carted away	4/6	11	0	6
(NOTE.—This price will vary according to the nature of the ground and amount of strutting.)				
9 ft. run, 6 in. tested glazed stoneware pipes, the joints made with cement and sand, including laying on 6 in. Portland cement concrete and covering with 6 in. do. after drains are tested, including digging 2 ft. 6 in. deep, filling in and ramming, remainder basketed and carted away...	4/-	1	16	0
3 ft. run, 6 in. do. do., but digging 4 ft. deep and do....	4/6	0	13	6
9 ft. run, 6 in. do. do., but deep digging, including any necessary planking and strutting from chambers to front vault	7/6	3	7	6
67 ft. run, 4 in. tested pipes, all as first described, digging average depth 2 ft. 6 in., and do. do.	3/9	12	11	3
2 extra only for 4 in. to 6 in. taper pipes...	1/3	0	2	6
6 extra to 4 in. bends	1/3	0	7	6
2 extra to 6 in. do.	1/9	0	3	6
3 cut holes through 4½ in. walls for 6 in. pipes, and form arched eyes	3/-	0	9	0
3 do., 9 in. do.	4/-	0	12	0
1 do., 14 in. do.	6/3	0	6	3
2 do., 22½ in. do....	8/9	0	17	6
Give notice to vestry and pay fees for connecting new drain to main sewer	100/-	5	0	0
Provide and fix a 12 in. fat trap flushing gully BB, with stone frame dished and rebated for iron cover ...	43/-	2	3	0
6 4 in. stoneware self-cleansing gullies, set on concrete, and connected to drain, gullies to have galvanised iron grids	8/9	2	12	6
Remove old brick dustbin, point and limewhite brickwork, and provide portable galvanised wrought iron dustbin	37/-	1	17	0

Inspection Chambers.

Form two inspection chambers, **W** and **Z**, as described, one in front area 3 ft. by 2 ft. 6in. by 4 ft. deep, inside measurement, one in middle area 3 ft. by 2 ft. by 2 ft. 6 in. deep; all as detail given below.				
6⅓ yds. cubic. Excavate, basket out, and cart away surplus earth	7/6	£2	7	6
5½ yds. super, 6 in. Portland cement foundations ...	2/6	0	13	9
89 ft. super, one-brick wall in cement	1/3	5	11	3
21 ft. run, labour and material, corbelling over to receive air-tight covers	1/-	1	1	0
10 yds. super, render walls in Portland cement ...	3/-	1	10	0
Form sloping benches in cement and prepare concrete bottom to receive half channel pipes	10/-	1	0	0
6 ft. run, 6 in. contracted outlet white glazed channel pipe, set in cement	2/6	0	15	0
7 4 in. white glazed channel curves	5/-	1	15	0
Provide and fix on proper cement concrete bed a syphon, with a 4 in. contracted inlet and 5 in. oulet, and connect on to outlet a 5 in. to 6 in. socket	25/-	1	5	0
Allow for bedding stopper of inspection eye in grease	1/6	0	1	6
6 ft. run, 4 in. galvanised iron pipe **DD** as air inlet, including chase in brickwork rendered in cement, and short length of 4 in. drain-pipe and easy bend connected to inspection chamber	3/6	1	1	0
1 4 in. galvanised mica inlet valve and fixing on end of pipe	12/-	0	12	0
4 eyes formed in the brick wall for 4 in. iron pipe to pass through	3/-	0	12	0
8 ditto 4 in. stoneware ditto	3/-	1	4	0
4 connexions of white glazed channels to 4 in. iron drain pipe	1/-	0	4	0
8 connexions of white glazed bends to 4 in. earthenware drain pipe	1/-	0	8	0
2 approved galvanised airtight covers and frames and fixing complete	65/-	6	10	0
Allow for cutting away and making good in all trades after all trades on the whole of the foregoing work not herein specified	200/-	10	0	0
		£390	0	2
Credit value of old materials		12	10	0
		£377	10	2

THE SUBURBAN VILLA.

REPORT AND SUGGESTIONS ON EXAMPLE III.

In this case the report is condensed, and it is assumed that the house is in an insanitary condition, which would probably be the case unless, indeed, it had been dealt with under recent regulations.

The roof is of red tiles with two steep gables that face the side road (it is a corner house). The roof over the back addition is a hipped lean-to.

119. *Rain-water Pipe No. 1.*—Provide a 2 in. galvanised iron rain-water pipe to carry off water from the gutter round the bay-window in front, with a double set-off and shoe, to deliver into gully **E**.

120. *Rain-water Pipe No. 2.*—Provide and fix between the main gables a 3½ in. galvanised iron rain-water pipe fitted with head and swan neck bend from the same, also a set-off for plinth projection and shoe, to carry off the water from the valley gutter into gully **D**.

121. *Rain-water Pipe No. 3.*—This takes the water from two sides of the hip roof and is to be a similar pipe to the last; but in place of the shoe at the foot it is carried into a 4 in. drain pipe under the paving, and is connected into a side inlet of the gully **C** in the centre of the paved yard.

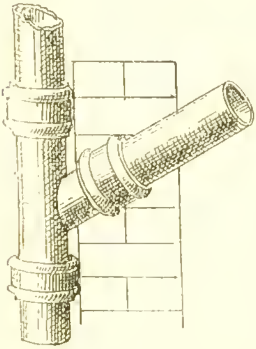
Note A A A.—This is done in order to avoid the length of unventilated drain which would otherwise be required.

122. *Rain-water Pipe No. 4.*—This takes the water from the half of the second gable which falls into the back gutter of the hip roof, the water from this back gutter and from the roof of the small bay window. Carry down a similar pipe as last, with a small 2 in. branch from the gutter of the bay, to deliver over gully **A**.

123. *Cisterns.*—There is a 150 gallon galvanised iron cistern in a small boxroom, formed in the roof over the bathroom. This supplies the house. The overflow is carried through

the roof. Provide a wooden lid to this cistern. There is already enough light and ventilation. As there is a constant water-supply the present services will not require alteration. Through the recommendations of the Commissioners on River Pollution many of the suburban water companies supply the several house fittings direct from the main, without the intermediate storage tank, and most allow one tap direct from the main. The recommendation runs as follows: "All storage of drinking water in the house is attended with the risk of pollution. Good water is spoiled and bad water is rendered worse by the intermittent system of supply. All drinking water ought to be drawn direct from the main."

FIG. 32.



124. *W.C. on First Floor.*—Remove the present defective valve closet together with the cast-lead trap and short length of lead soil-pipe. At present this short length of pipe is connected into a common 4 in. cast-iron rain-water pipe, the joint is made with red lead in the thickness of the wall thus (see Fig. 32) and is very defective. Lay lead safe with front edge turned over the fillet and carry 1½ in. overflow through the external wall. Provide and fix a combination lead pedestal closet with slop top, one that enables the connexion to the soil-pipe to be made by means of a plumber's soldered joint.

Note B B B.—The objection before stated as to the ordinary cast lead traps, on account of their internal roughness and liability to sand holes, is much less in the case of these closets, as they are mostly cast under pressure. The trap also is in sight above the floor line, so that any leakage could at once be seen. They must be tested by water. (See par. 24.)

125. *Recommendation.*—Carry a short length of 10 lb. 3½ in. lead soil-pipe from the top closet, the end to be fitted with a brass sleeve piece, and form a caulked lead joint into long branch of new iron soil-pipe, or a still better plan is to use the short arm, but turn it so that the connexion with the lead pipe is outside the house. This iron pipe in order to meet the requirements of the London County Council must weigh 56 lb. to the 6 ft. length,

and should be at least ¼ in. in thickness. (See Fig. 33.) Connect a 2 in. strong lead anti-syphonage pipe on to the out-go of the trap and carry it through the outer wall. (See par. 131 and Note o in first example.) Provide and fix on suitable cast-iron brackets a 3 gallon silent water-waste preventer. Lay on the water to the same from the old service to the closet by a ½ in. lead service and connect a 1¼ in. down service from the cistern through the external wall. Supply and fix a hinged mahogany seat as supplied with closet. (Fig. 34.) The seat shown is self-raising worked by means of a loaded end. (See dotted lines.)

FIG. 33.

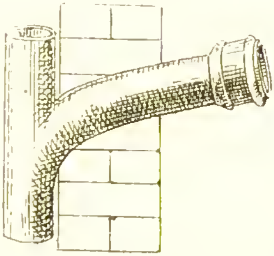
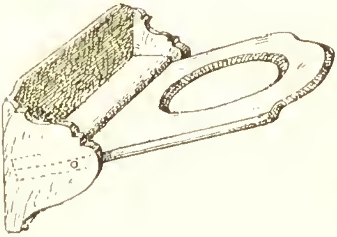
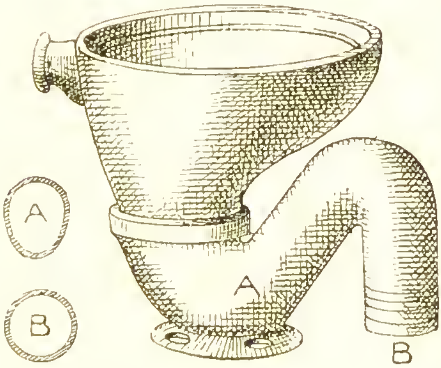


FIG. 34.



126. *W.C. in Yard.* Remove the present side wash-out closet and fix in place of the same a short hopper basin with flushing rim and stoneware glazed S trap under. Build a brick pedestal to carry the basin and cement the same; also the floor where not already done under seat and the brickwork round the back and sides of the closet. Provide and fix a stout deal hung seat, with brackets to carry the same, and paint this and new-cement underneath.

FIG. 35.

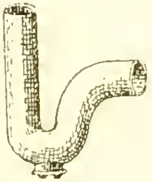


Note c c c.—This (Fig. 35) is an excellent one, both on account of the shape of the pan and also for the readiness with which it is flushed, owing to the contraction in the bottom of the trap.

127. *Lavatory Basin* **L**.—This is a white glazed basin with brass plug-waste. Supply and fix a 1¼ in. drawn lead syphon-trap (Fig. 36) under the same, fitted with brass cleansing screw and connect into the bath-waste. Carry a short 1¼ in. anti-syphonage pipe just through the external wall with + copper guard on the end of the pipe. (See par. 42, first example.)

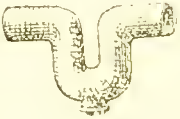
128. *Bath*.—This bath, though a cheap one, is very good from a sanitary point of view, being far better than if enclosed with a wooden case. It is a cast-iron parallel bath with a rolled edge, it stands upon feet independently, and is supplied by two bibcocks at the foot. It is fitted with plug and chain waste. Disconnect this 1¼ in. waste from the old rain-water pipe, lengthen and continue down to the gully **B** by the scullery window. Disconnect the bath and provide and fix in waste under same a drawn 1¼ in. running stout lead trap with brass cleansing screw. (Fig. 37.) Carry up this 1¼ in. waste as anti-syphonage pipe through the projecting eaves of the roof to stand up about 12 in. above the same and make good to slate with lead collar with a 1 in. branch from outgo of trap into same. Refix the bath and make good all connexions, including overflow.

FIG. 36.



P trap.

FIG. 37.



Running trap.

129. *Hot Water System*.—There is a 40 gallon hot-water tank in the cupboard in this bathroom with an expansion pipe turned over the cistern in the box-room. It is heated from the kitchen boiler. There should be a ¾ in. dead weight safety-valve fixed on a short length of steam pipe carried from the top of the kitchen boiler.

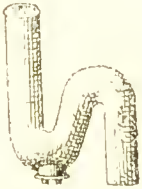
130. *Scullery Sink*.—This is a stone sink. After the removal of old waste, &c., provide and fix a brass grate and union. Carry a 2½ in. strong lead waste from the same to deliver into the external gully **B**. Provide and

fix under the sink a strong drawn lead S-trap, fitted with brass cleansing screw (Fig. 38), with a 1½ in. anti-syphonage pipe through the external wall.

Provide a short ½ in. branch stout lead pipe from rising main fitted with a high-pressure screw-down bibcock to supply sink.

131. *Soil Pipe* **H.**—This pipe from the first-floor closet is a common light cast-iron rain-water pipe. It is continued up to the eaves and gutter in zinc to act as a rain-water pipe and ventilator. This must be removed entirely. A moderately stout 3½ in. galvanised cast-iron special soil-pipe, weighing 56 lb. to the 6 ft. length, fitted with ears for fixing, and large collars for caulked joints, must be carried up in place of the old pipe. The joints must be all caulked in the usual way and run with lead, and the connexions with the soil-pipe of the first-floor w.c. and the anti-syphonage pipe from the same made by means of proper iron junctions and brass thimble (see Fig. 1), or the anit-syphonage pipe may be screwed into the iron pipe with a brass union and back-nut. This last pipe is to enter the soil-pipe about 2 ft. above the joint of the closet branch. The upper end of the soil-pipe is to be carried through the eaves of the back addition and either run up to 12 in. above the ridge or to stand up about 5 ft. above the gutter, fixed with proper iron stays and copper wire guard on top, the hole in the eaves to be made good with lead collar.

FIG. 38.



S trap.

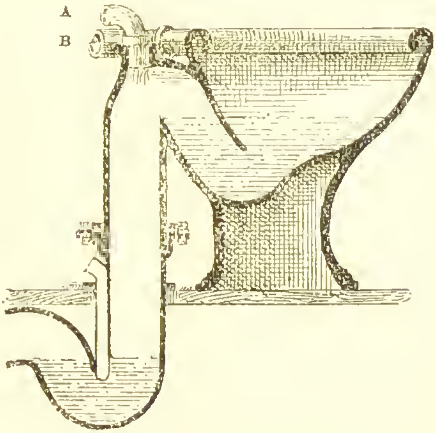
132. *Ventilating Pipes.—Outlet-Pipe.*—Carry up at the end of the drain, in the corner formed by the bay window of the kitchen, a 4 in. cast-iron pipe, like that used for the soil-pipe, continued through the projecting eaves to finish about 4 ft. through the roof. Make good with lead collar and fit a copper wire guard on top of the pipe.

133. *Inlet-Pipe.*—Unless this side where the inlet is shown had been much cooler than the side where the outlet is fixed in the garden, this pipe should have been carried up in the corner by the chimney stack to within 4 ft. of the top, not higher, that the drain air may not be drawn into the flues, in all other respects as the last pipe. This, however, being the cold side, it will be sufficient to carry it up about 2 ft. only above the ground, fitted on the top with an inlet grating. (See Note z ii, Example II.)

134. *Drains.*—After the removal of the old drains and wet earth (see provisional amount) dig out ground for disconnecting chamber **J.** Form on a 6 in. concrete bottom and build in 9 in. brickwork in cement a chamber 3 ft. long by 2 ft. 3 in. wide. Fix on the concrete at the outlet a syphon trap, as shown in illustration. (Note z ii in first example.) Fix in the bottom of the manhole with a fall of 6 in. in the 3 ft. a 5 in. taper channel-pipe with egg-shaped outlet. Lay channel-bend to receive the drain from the gully and form banks at the side of the chamber, as shown in section. Lay down on a proper concrete bed, level with top of, and connected into, chamber, a 6 in. glazed drain-pipe to connect with the fresh air inlet-pipe. Gather over brickwork at top of the chamber to receive a stout cast-iron galvanised manhole cover and supply and fix same. Build a manhole or inspection chamber **G** at the corner in the garden in the same way as described for inspection chamber, but with the omission of the syphon trap and the inlet ventilator, the channel pipe to be the same size at each end. Dig out ground to form a trench from the top end of the drain to the boundary of the premises, with a fall throughout to sewer of half an inch to each pipe, the 6 in. fall in the chamber not included, the trench to be of sufficient width at the bottom to allow a man to walk with one foot on each side of the pipes without treading on them when laid, and to have the sides to slope at an angle of not less than 80°. Lay a 6 in. bed of concrete, and on the same lay, as shown on plan, a 6 in. glazed stoneware London-made drain, with 4 in. branches from gullys, w.c.'s, &c., each pipe to be laid carefully with a proper cement joint, each joint to be wiped out inside so as not to leave any rough internal edges. Fill in with concrete all round the pipes after the drains have been tested with water and passed. Gullies **A, D,** and **E** are to be fitted with half channel side inlets and galvanised wire covers. Gully **B** to have an egg-shaped bottom with back inlet

for scullery sink waste and a side inlet for waste of bath. At completion the trenches are to be carefully filled in and levelled, and all cutting away, &c., made good. Make good the cement paving in enclosed yard with a proper fall each way into the new gully. Test again with water, and after the manhole covers have been bedded down with grease test by some well-known chemical means.

FIG. 39.



A Syphonic Jet. B Supply to Basin.
First pattern, Syphonic Closet.

Note D D D.—No reference has yet been made to the latest departure in the manufacture of closets. The syphonic principle is an alluring one to the plumber. It offers a closet that will give as large a body of water as that contained in the basin of a valve closet, a deeper water seal in the trap, and at the same time dispenses with the somewhat complicated mechanism that forms the valve closet's chief drawback. The form of the first closet of this pattern invented is shown in Fig. 39.

ESTIMATE

For proposed Alterations and Sanitary Work as explained in Specification and shown on Plan. (EXAMPLE III.)

Work to Rain-water Pipes.		£	s.	d.
Remove the whole of rain-water pipes, and make good	25/-	1	5	0
13 ft. run, 2 in. galvanised iron rain-water pipe to front bay	-/10	0	10	10
1 2 in. plinth bend	1/8	0	1	8
1 2 in. shoe	1/-	0	1	0
28 ft. run, 3½ in. galvanised iron rain-water pipe to valley gutter	1/4	1	17	4
1 3½ in. swan neck	4/3	0	4	3
1 3½ in. head	3/6	0	3	6
1 3¼ in. plinth bend	2/6	0	2	6
1 3½ in. shoe	1/10	0	1	10

28 ft. run, 3½ in. galvanised iron rain-water pipe to two sides of hip roof	1/4	£1	17	4
1 3½ in. swan neck	4/3	0	4	3
1 3½ in. head	3/6	0	3	6
1 3½ in. plinth bend	2/6	0	2	6
24 ft. run, 3½ in. galvanised iron rain-water pipe at back	1/4	1	12	0
1 3½ in. swan neck	4/3	0	4	3
2 3½ in. heads	3/6	0	3	6
1 3½ in. shoe	1/10	0	1	10
2 ft. 6 in. run, 2 in. galvanised iron rain-water pipe to back bay	-/10	0	2	1

Cistern.

1 ¾ in. matched boarded ledged cover to 150 gallon cistern	10/-	0	10	0

Work to Water-closets.

Remove present valve closet first floor and its connexions and make good	10/-	0	10	0
Milled lead to safe	12/-	0	12	0
3 ft. run, 1 in. by 1½ in. deal fillet, and labour dressing lead	-/6	0	1	6
2 ft. run, 1½ in. lead overflow	1/8	0	3	4
1 1½ in. joint	2/10	0	2	10
Provide and fix a combination lead pedestal closet with french polished hinged mohogany seat	90/-	4	10	0
1 short branch of 3½ in. 10 lb. lead bent pipe, about 3 ft. 6 in. long, and joint to trap	30/-	1	10	0
1 3½ in. brass thimble and joint to iron pipe	11/-	0	11	0
4 ft. run, 2 in. lead anti-syphonage pipe...	2/6	0	10	0
1 2 in. joint	3/4	0	3	4
1 3 gallon silent water-waste preventer, and fixing on cast-iron brackets	32/-	1	12	0
2 ft. 6 in. run, ½ in. lead supply	-/9	0	1	10
2 ½ in. joints	1/7	0	3	2
2 ft. run, ¾ in. lead overflow pipe from water-waste preventer	1/9	0	3	6
1 ¾ in. joint	1/1	0	1	1
6 ft. run, 1¼ in. lead flush pipe	1/4	0	8	0
2 1¼ in. joints	2/6	0	5	0
1 ft. 6 in. run, 1 in. lead overflow	1/2	0	1	9
1 1 in. joint	2/-	0	2	0
Remove present wash-out closet in yard, and make good	5/-	0	5	0
Provide and fix a short hopper basin, with flushing rim and stoneware glazed P trap carried on brick pedestal, and connect to drain	30/-	1	10	0
3 yards super. Portland cement rendering	3/-	0	9	0
1 deal hinged seat fixed with brackets	26/-	1	6	0
Re-connecting and altering supplies	20/-	1	0	0

Lavatory.

Disconnect waste to lavatory and fix 1¼ in. lead syphon trap, with cap and screw	5/-	0	5	0
3 1¼ in. joints	2/6	0	7	6
1 1¼ in. anti-syphonage pipe, about 2 ft.	3/6	0	3	6
1 1¼ in. joint	2/6	0	2	6
1 copper guard to 1¼ in. pipe and soldering	1/-	0	1	0

Bath.

		£	s.	d.
Disconnect bath waste from old rain-water pipe and also waste to bath	7/6	£0	7	6
11 ft. run, 1¼ in. lead waste to bath	1/4	0	14	8
1 1¼ in. lead syphon trap, with cap and screw	3/-	0	3	0
2 1¼ in. joints	2/6	0	5	0
18 ft. run, 1¼ in. lead anti-syphonage pipe carried up through eaves	1/4	1	4	0
1 1¼ in. joint	2/6	0	2	6
Make good to slate roof with lead collar and soldering to pipe	10/-	0	10	0
Refix bath and make good all connexions	20/-	1	0	0
Drill hole in top of kitchen boiler and fix short length of 1 in. pipe, with dead-weight safety valve	22/-	1	2	0

Sink.

		£	s.	d.
Remove old waste to scullery sink	3/6	0	3	6
3 ft. run, 1½ in. lead waste	1/4	0	4	0
1 1½ in. lead syphon trap, with cap and screw	5/-	0	5	0
2 1½ in. joints	2/10	0	5	8
1¼ in. lead anti-syphonage pipe about 1 ft. 6 in.... ...	3/6	0	3	6
1 1¼ in. joint	2/6	0	2	6
1 copper guard to 1¼ in. pipe and soldering	1/-	0	1	0
12 ft. stout ½ in. lead service	-/9	0	9	0
1 ½ in screw-down high-pressure bibcock	4/10	0	4	10
2 ½ in. soldered joints	1/7	0	3	2

Soil-pipe.

		£	s.	d.
Remove present soil-pipe and make good...	12/6	0	12	6
28 ft. run, 3½ in. galvanised iron soil-pipe, with ears for fixing, and large collar, the joints to be caulked with lead	2/6	3	10	0
1 3½ in. copper wire balloon	3/-	0	3	0
1 set of iron stays for securing pipe	10/-	0	10	0
1 hole through eaves, lead, slate, and soldering ...	10/-	0	10	0
1 3½ in. junction to galvanised iron pipe	5/-	0	5	0
1 2½ in. do. do. do.	2/6	0	2	6
1 3½ in. brass collar with easy bend, and connect to drain	12/6	0	12	6
23 ft. run, 4 in. cast-iron ventilating pipe to drain, joints caulked with tow and red lead	1/2	1	6	10
1 4 in. copper wire balloon	3/-	0	3	0
1 set of iron stays for securing pipe	10/-	0	10	0
1 hole through eaves, with lead, slate, and soldering...	10/-	0	10	0
1 4 in. brass collar with easy bend, and connect to drain	12/6	0	12	6

Work to Drains.

		£	s.	d.
Remove old drain and make good	250/-	12	10	0
31 ft. run, 4 in. stoneware tested drain-pipe, joints make with cement and sand laid on 6 in. Portland cement concrete, and cover all round with ditto, including digging, average depth 1 ft., filling in, and ramming ...	3/-	4	13	0
21 ft. run, 4 in. ditto, ditto, and ditto, but digging average depth 2 ft., and ditto	3/6	3	13	6
29 ft. run, 6 in. stoneware tested drain pipe, all as last described and digging average depth of 1 ft. ...	3/6	5	1	6
57 ft. run, 6 in. ditto, ditto, but digging 2 ft., and ditto	4/0	11	8	0

7 extra to 4 in. bends	1/3	£0	8	9
4 extra to 6 in. by 4 in. junction	1/9	0	7	0
3 extra to taper pipes	1/3	0	3	9
9 ft. run, 6 in. stoneware tested drain pipe, but deep digging, including any necessary planking and strutting	5/9	2	11	9
1 connexion with main sewer and pay all necessary fees	100/-	5	0	0
4 gullies and grids, set in concrete and connected to drain	8/9	1	15	0
1 gully with egg-shaped bottom, with back inlet for scullery sink	15/-	0	15	0
7 yards super., make good cement paving	2/6	0	17	6

Inspection Chambers.

Form inspection chambers, one 3 ft. by 2 ft. 3 in by 1 ft. deep, and one 3 ft. by 2 ft. 3 in. by 2 ft. 6 in. deep, as follows:—

4 yards cube, dig and cart away surplus earth	7/6	1	10	0
1 yard cube, Portland cement concrete foundation	15/-	0	15	0
47 ft. super., 1 brick in cement	1/3	2	18	9
5½ yards super., Portland cement rendering	3/-	0	16	6
5 ft. run, 6 in. white glazed channels	2/3	0	11	3
1 6 in. white glazed channel bend	6/-	0	6	0
2 4 in. ditto ditto	5/-	0	10	0
4 holes through inspection chamber for 6 in. pipe and make good	1/6	0	6	0
3 ditto for 4 in. pipe	1/6	0	4	6
2 form sloping benches and prepare bottom of chamber to receive channel pipes	10/-	1	0	0
1 6 in. syphon trap set in concrete and connect with drain	15/-	0	15	0
Seal off old connexion to drain	10/-	0	10	0
Short piece of 4 in. galvanised iron pipe for fresh-air inlet	7/-	0	7	0
1 4 in. fresh-air inlet and fixing	12/-	0	12	0
2 approved cast-iron galvanised manhole covers and fixing	65/-	6	10	0
21 ft. run, corbelling brickwork to receive inspection cover	1/-	1	1	0
Allow for cutting away for and making good in all trades after all trades on the foregoing work	70/-	3	10	0
		£114	17	5

PART II.

REPORT OF

The Lancet Special Commission

ON THE

WATER SUPPLY AND DISPOSAL OF SEWAGE IN RURAL DISTRICTS

Being an Inquiry Supplementary to The Lancet Special Commission on the Relative Efficiency and Cost of Plumbers' Work.

[*THE LANCET, MARCH 4, 1899.*]

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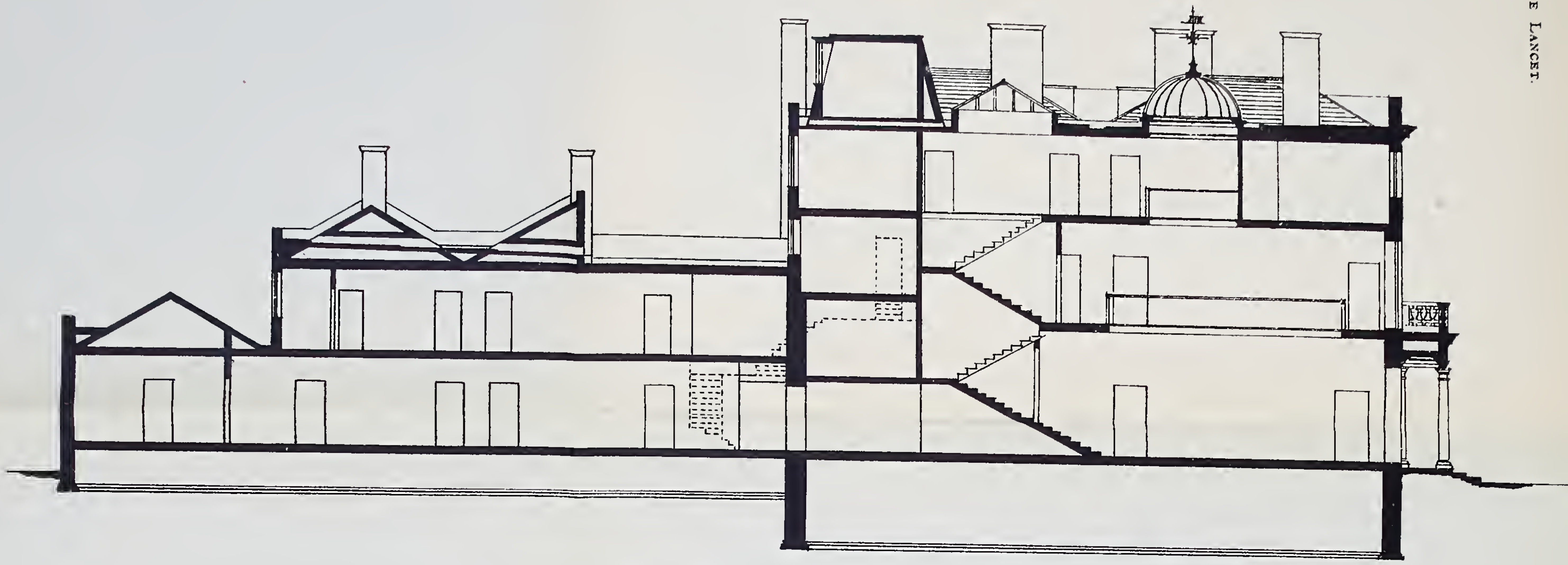


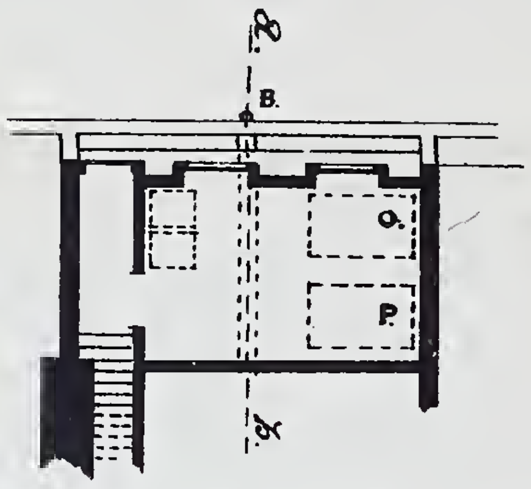
No. 4 Section. a.-b.
existing.

ROOF PLAN No. 1 AMENDED.

A Rain-water pipe, Par. 108.
B " " Par. 110.
C " " Par. 110.
D " " Par. 112.
E " " Par. 114.
F " " Par. 114.
FF Soil-pipe to w.c. T, Par. 147.
GG " " S and V, Par. 149.
HH " " U, Par. 151.
TT Bath and sink wastes, Par. 159 and 169.
UU " " Par. 157 and 167.

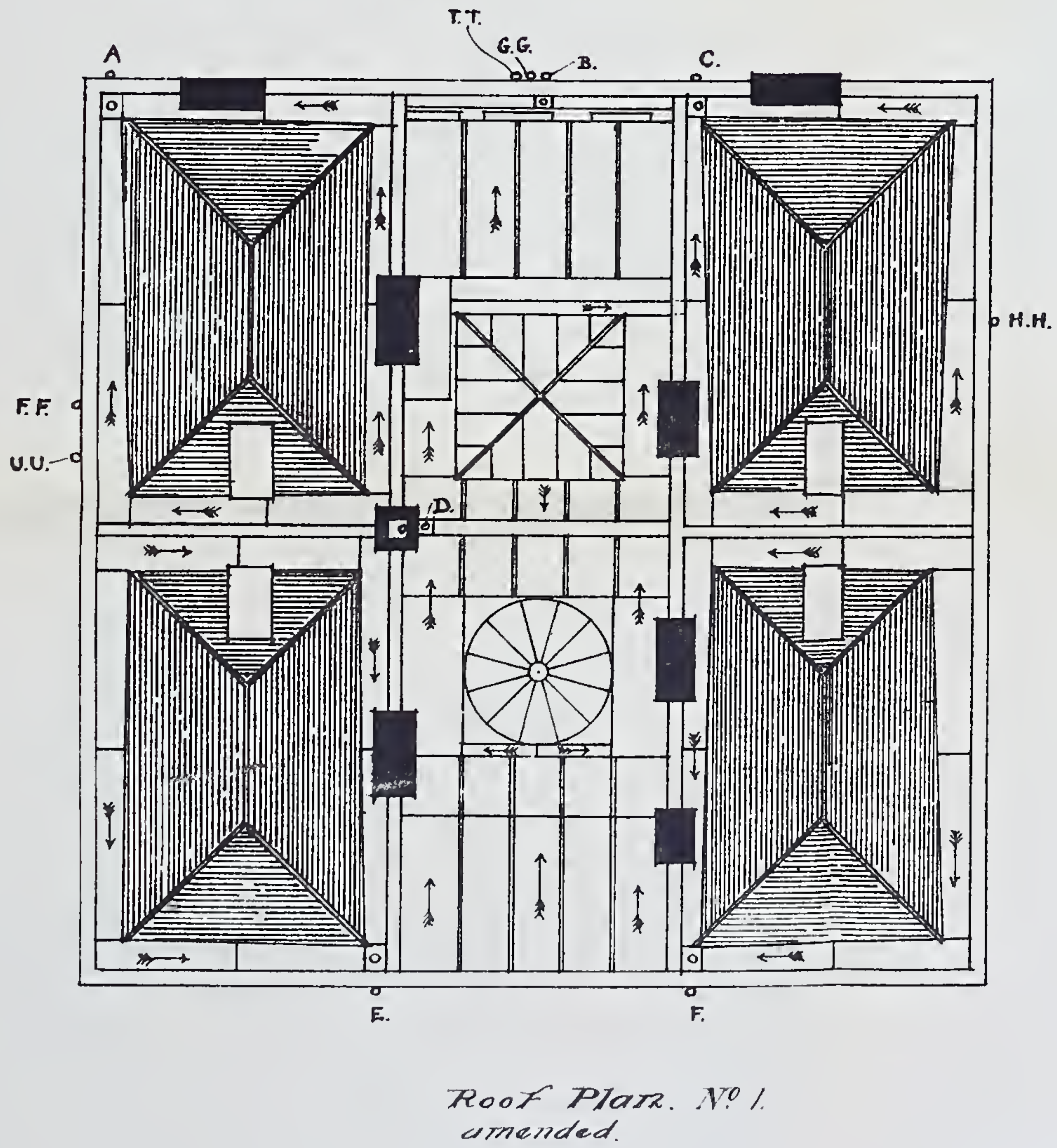
ROOF PLAN No. 2, EXISTING.

A Rain-water pipe, Par. 107.
B " " Par. 109.
C Non-existent.
D Rain-water pipe; also soil-pipe from w.c. T, &c., Par. 111.
E Rain-water pipe, Par. 113.
F " " Par. 113.

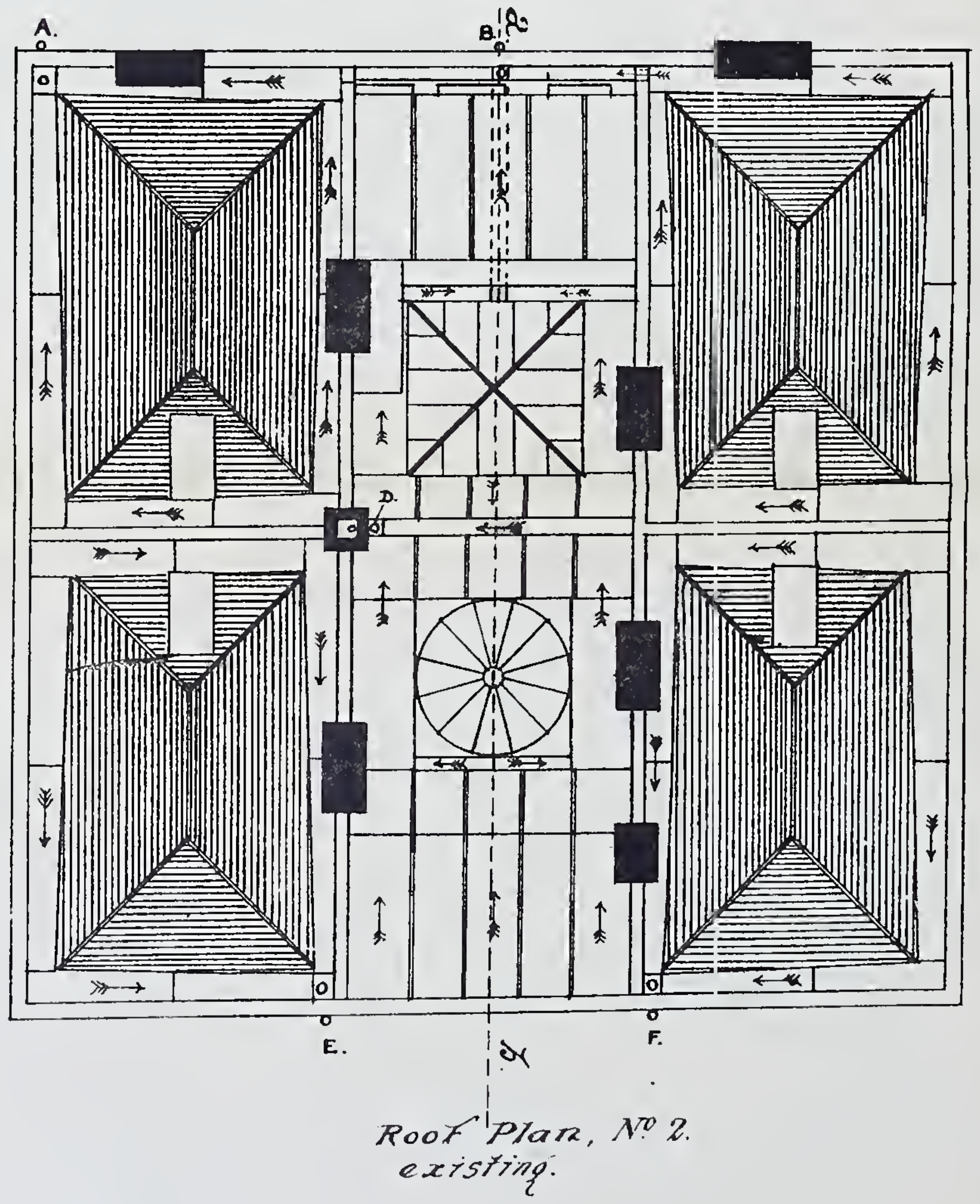


No. 3. Plan of Cistern Room.

O Cistern supplying drinking-water to sinks, &c., Par. 124.
P Cistern supplying w.c.'s, Par. 126.



Roof Plan. No. 1.
amended.



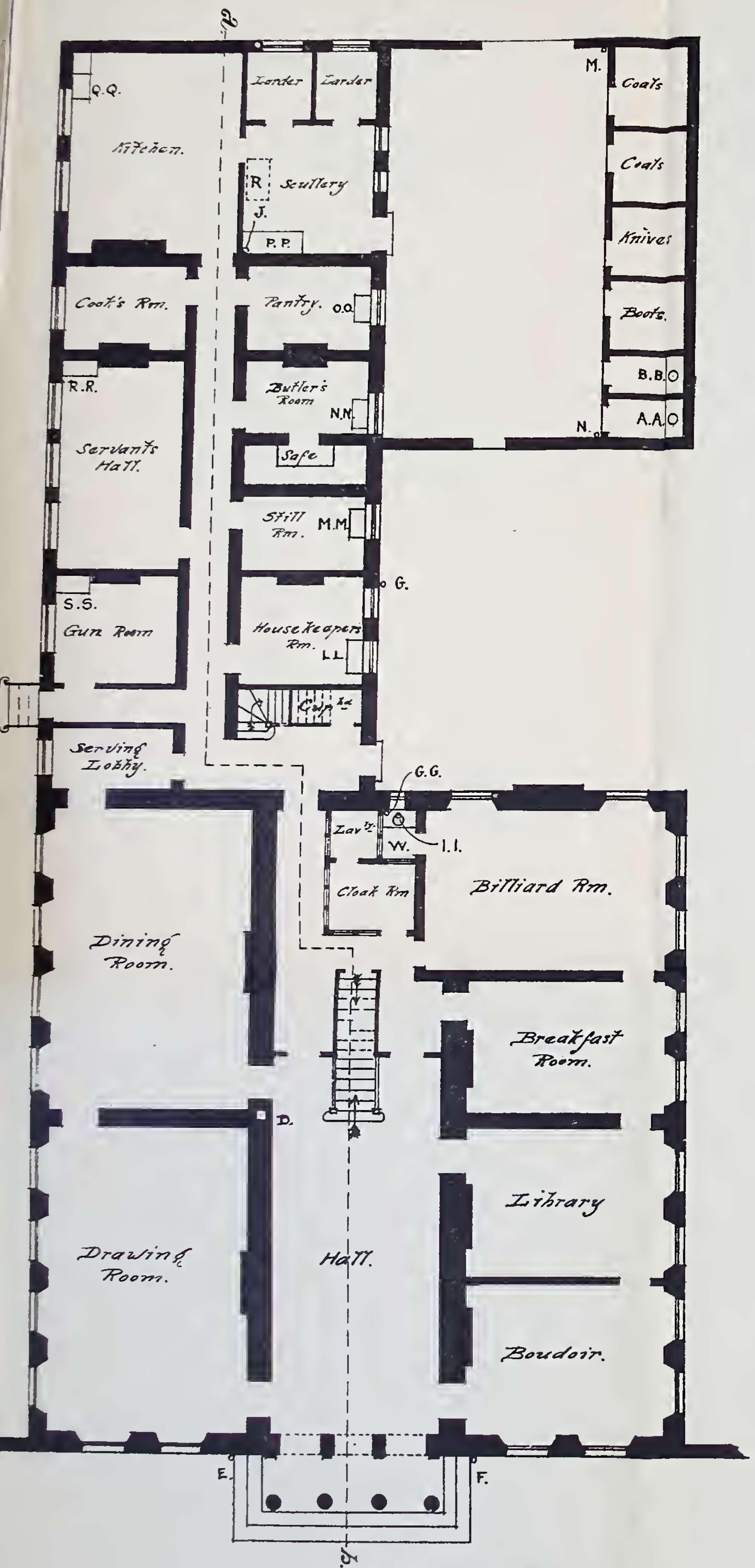
Roof Plan, No. 2.
existing.

Existing Plans No. 5, 6, and 7.

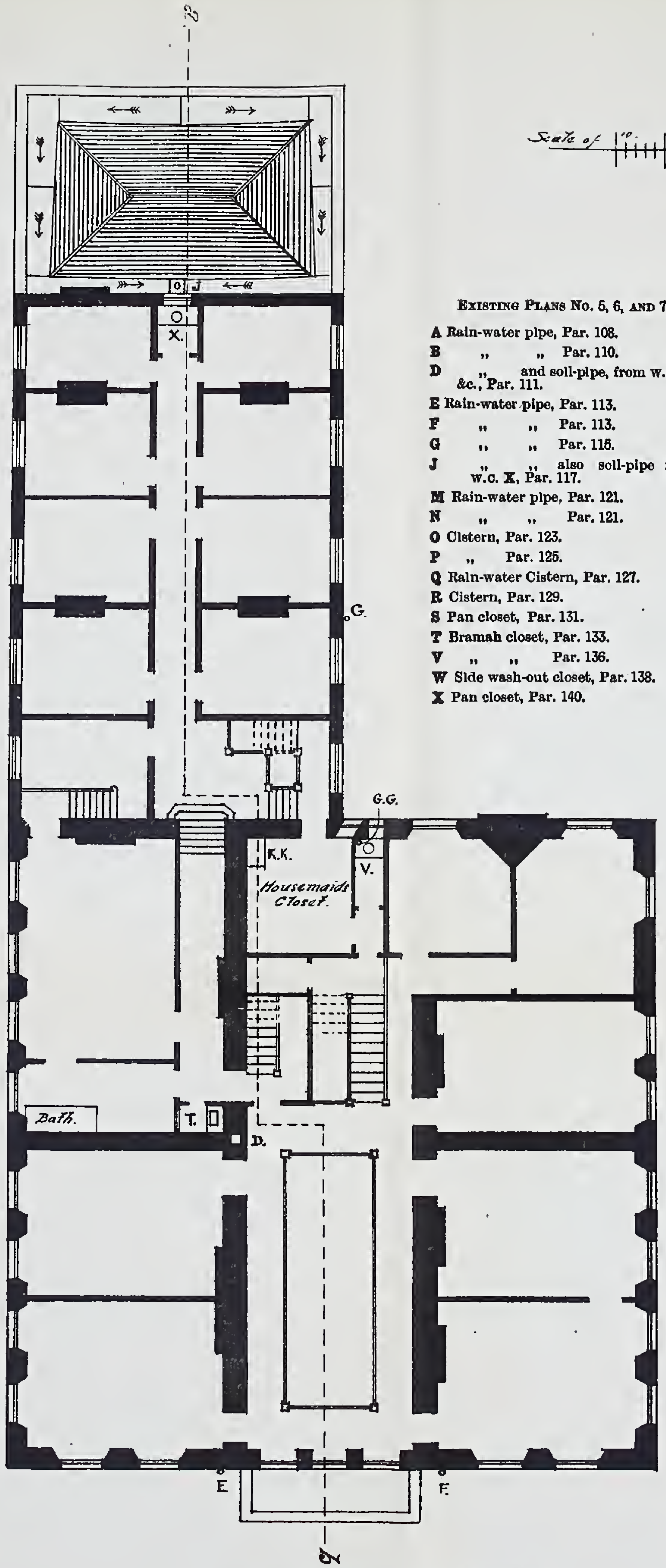
A	Rain-water pipe, Par. 108.
B	,, ,, Par. 110.
D	,, and soil-pipe, from w.c. **T**, &c., Par. 111.
E	Rain-water pipe, Par. 113.
F	,, ,, Par. 113.
G	,, ,, Par. 116.
J	,, ,, also soil-pipe from w.c. **X**, Par. 117.
M	Rain-water pipe, Par. 121.
N	,, ,, Par. 121.
O	Cistern, Par. 123.
P	,, Par. 125.
Q	Rain-water Cistern, Par. 127.
R	Cistern, Par. 129.
S	Pan closet, Par. 131.
T	Bramah closet, Par. 133.
V	,, ,, Par. 136.
W	Side wash-out closet, Par. 138.
X	Pan closet, Par. 140.

Existing Plans No. 5, 6, and 7.

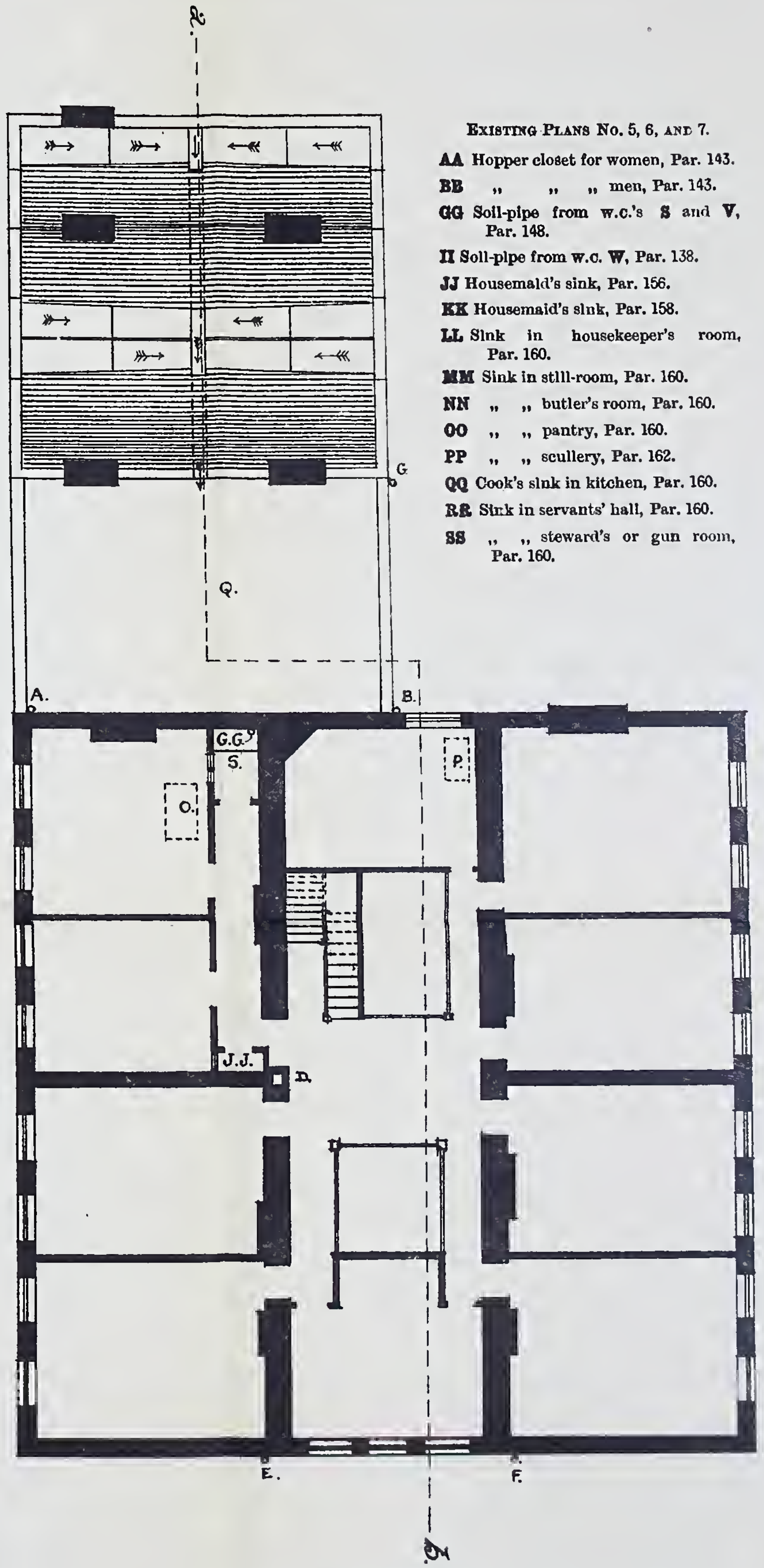
AA	Hopper closet for women, Par. 143.
BB	,, ,, ,, men, Par. 143.
GG	Soil-pipe from w.c.'s **S** and **V**, Par. 148.
II	Soil-pipe from w.c. **W**, Par. 138.
JJ	Housemaid's sink, Par. 156.
KK	Housemaid's sink, Par. 158.
LL	Sink in housekeeper's room, Par. 160.
MM	Sink in still-room, Par. 160.
NN	,, ,, butler's room, Par. 160.
OO	,, ,, pantry, Par. 160.
PP	,, ,, scullery, Par. 162.
QQ	Cook's sink in kitchen, Par. 160.
RR	Sink in servants' hall, Par. 160.
SS	,, ,, steward's or gun room, Par. 160.



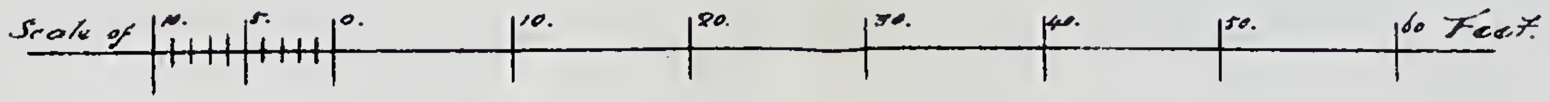
Ground Floor Plan, No. 5.
existing.

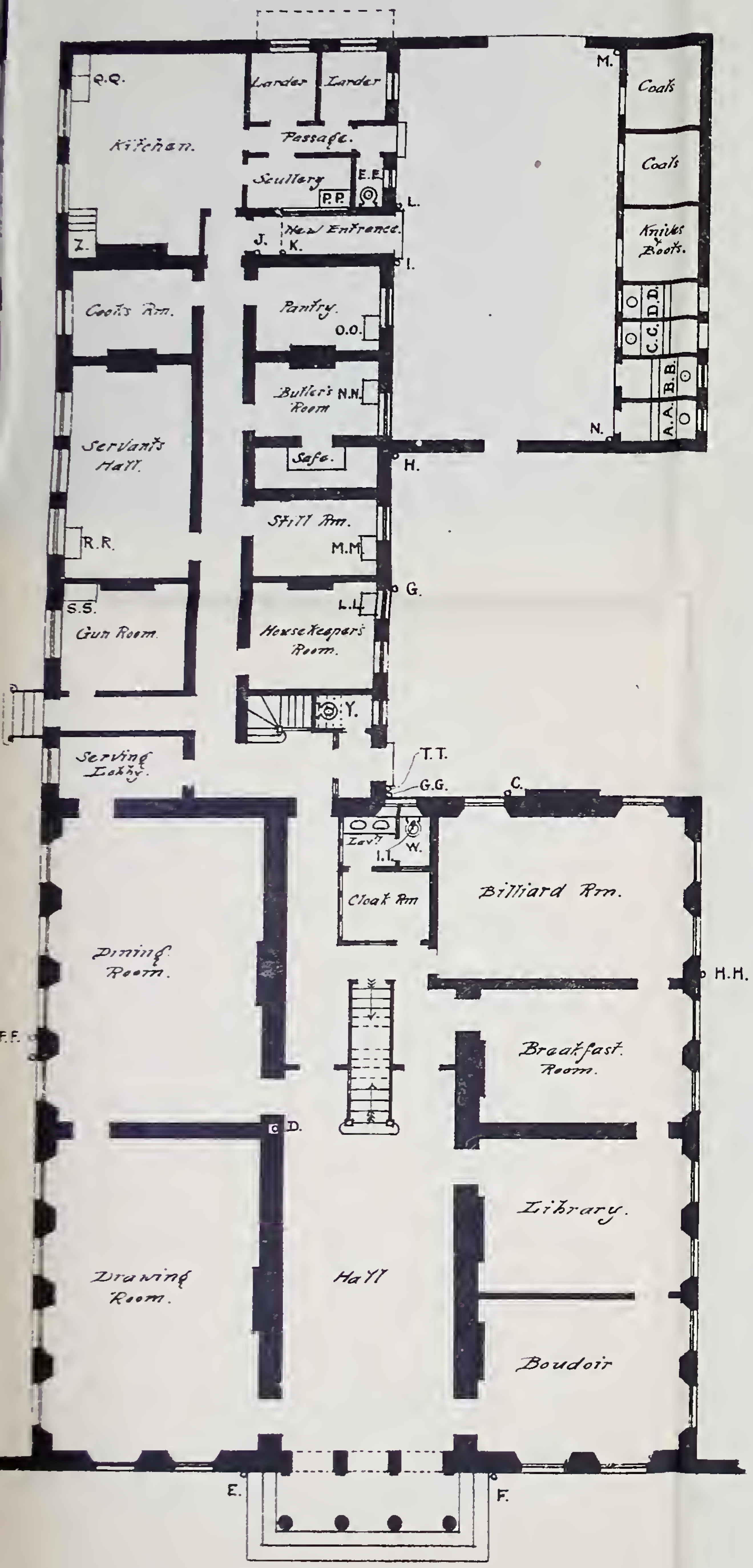


First Floor Plan, No. 6.
existing.

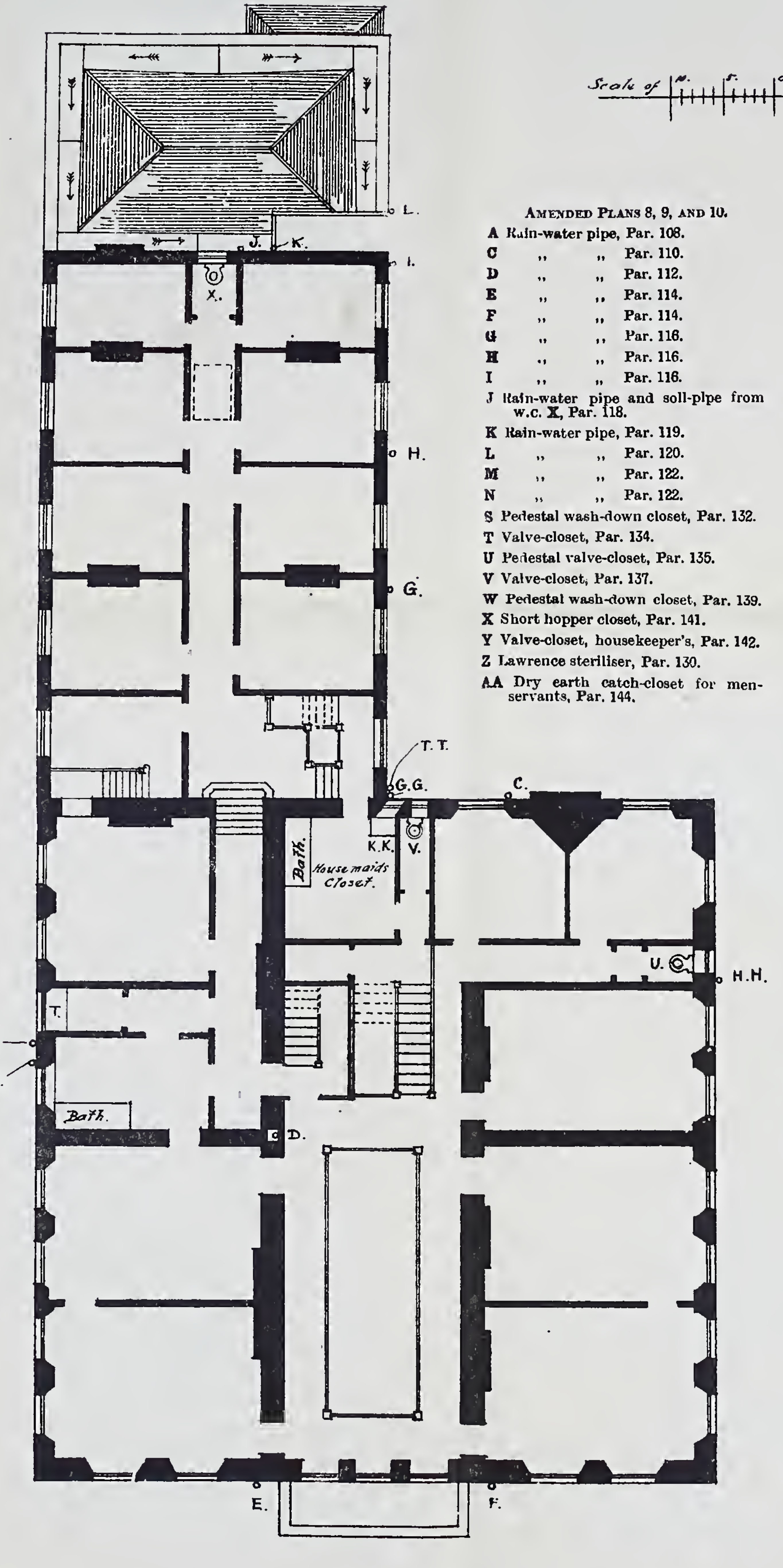


Second Floor Plan, No. 7.
existing.





Ground Floor Plan, No 8.
amended.



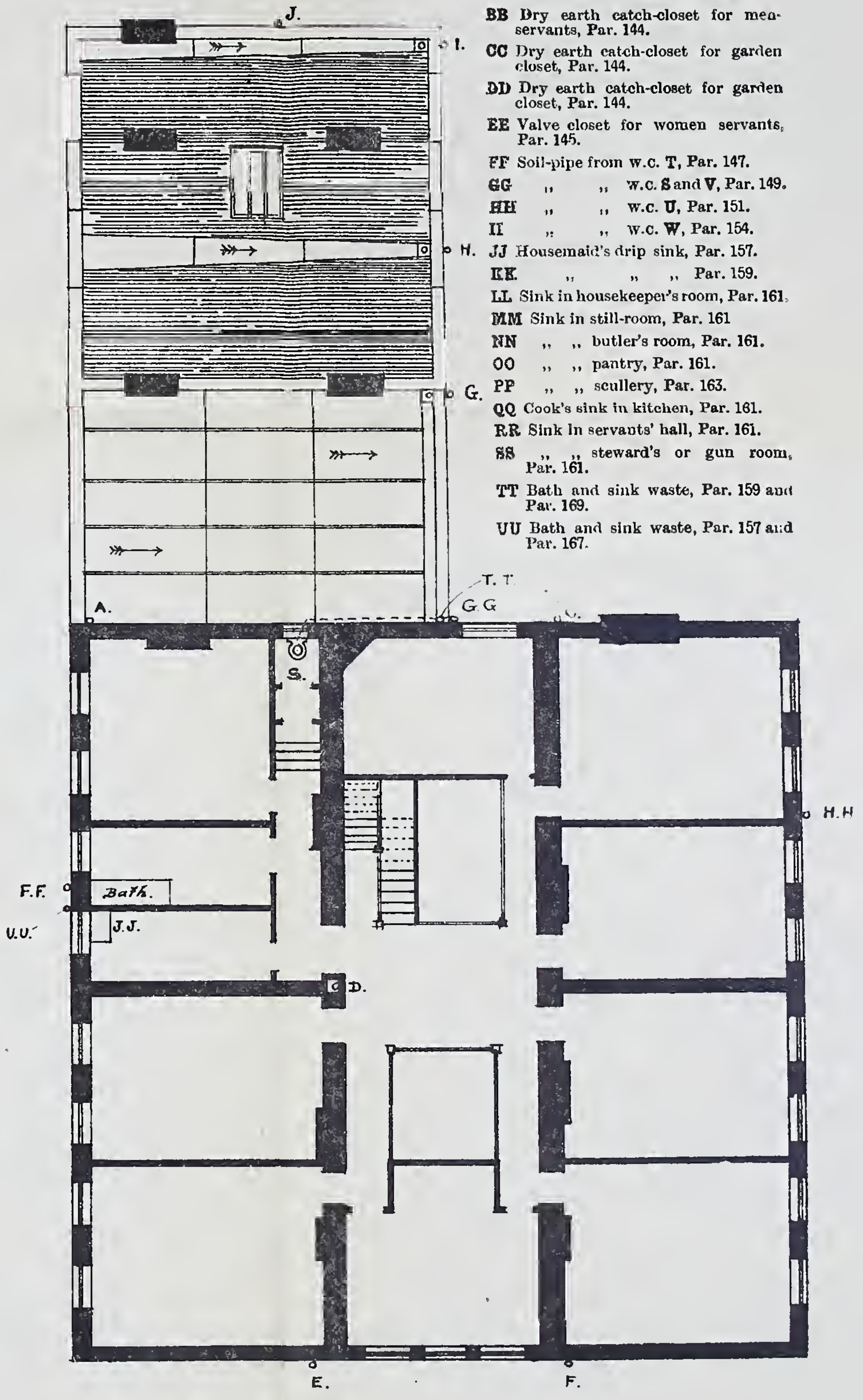
First Floor Plan No 9.
amended.

AMENDED PLANS 8, 9, AND 10.

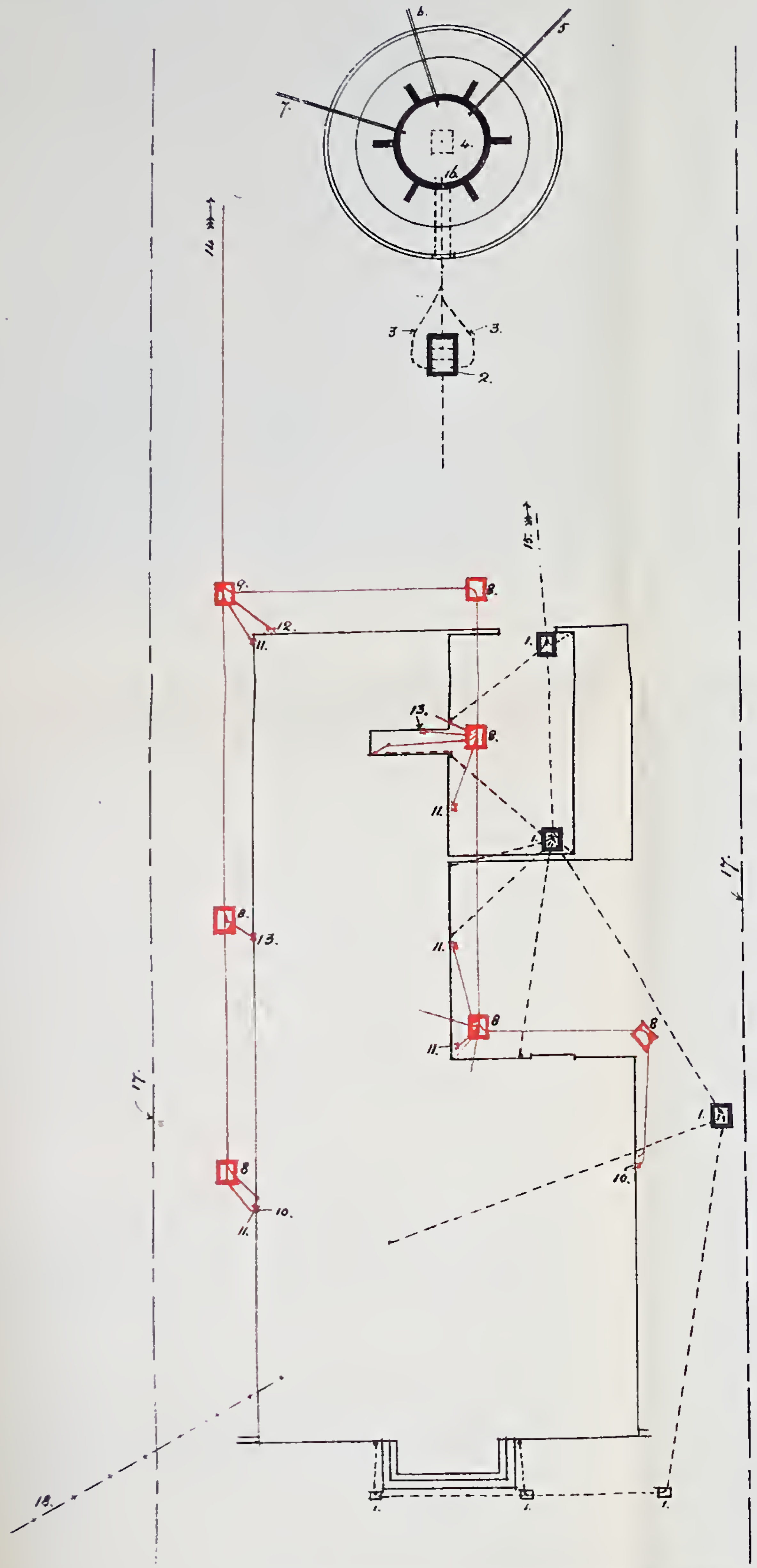
A	Rain-water pipe, Par. 108.
C	,, ,, Par. 110.
D	,, ,, Par. 112.
E	,, ,, Par. 114.
F	,, ,, Par. 114.
G	,, ,, Par. 116.
H	,, ,, Par. 116.
I	,, ,, Par. 116.
J	Rain-water pipe and soil-pipe from w.c. **X**, Par. 118.
K	Rain-water pipe, Par. 119.
L	,, ,, Par. 120.
M	,, ,, Par. 122.
N	,, ,, Par. 122.
S	Pedestal wash-down closet, Par. 132.
T	Valve-closet, Par. 134.
U	Pedestal valve-closet, Par. 135.
V	Valve-closet, Par. 137.
W	Pedestal wash-down closet, Par. 139.
X	Short hopper closet, Par. 141.
Y	Valve-closet, housekeeper's, Par. 142.
Z	Lawrence steriliser, Par. 130.
AA	Dry earth catch-closet for men-servants, Par. 144.

AMENDED PLANS 8, 9, AND 10.

BB	Dry earth catch-closet for men-servants, Par. 144.
CC	Dry earth catch-closet for garden closet, Par. 144.
DD	Dry earth catch-closet for garden closet, Par. 144.
EE	Valve closet for women servants, Par. 145.
FF	Soil-pipe from w.c. **T**, Par. 147.
GG	,, ,, w.c. **S** and **V**, Par. 149.
HH	,, ,, w.c. **U**, Par. 151.
II	,, ,, w.c. **W**, Par. 154.
JJ	Housemaid's drip sink, Par. 157.
KK	,, ,, ,, Par. 159.
LL	Sink in housekeeper's room, Par. 161.
MM	Sink in still-room, Par. 161
NN	,, ,, butler's room, Par. 161.
OO	,, ,, pantry, Par. 161.
PP	,, ,, scullery, Par. 163.
QQ	Cook's sink in kitchen, Par. 161.
RR	Sink in servants' hall, Par. 161.
SS	,, ,, steward's or gun room, Par. 161.
TT	Bath and sink waste, Par. 159 and Par. 169.
UU	Bath and sink waste, Par. 157 and Par. 167.



Second Floor Plan, No 10.
amended.



1. Inspection chambers and cleansing eyes on rain-water drain.
2. Filter on rain-water drain, Par. 21.
3. Overflows to filter, Par. 181.
4. Rain-water tank, Par. 182.
5. Inlet taking rain-water from laundry buildings.
6. Inlet taking rain-water from stable buildings.
7. Overflow from rain-water drain carried to pond.
8. Inspection chambers on soil drains.
9. Intercepting chamber, Par. 195.
10. Position of discharge from flushing tanks fixed in cistern room, Par. 196, Note *P.*
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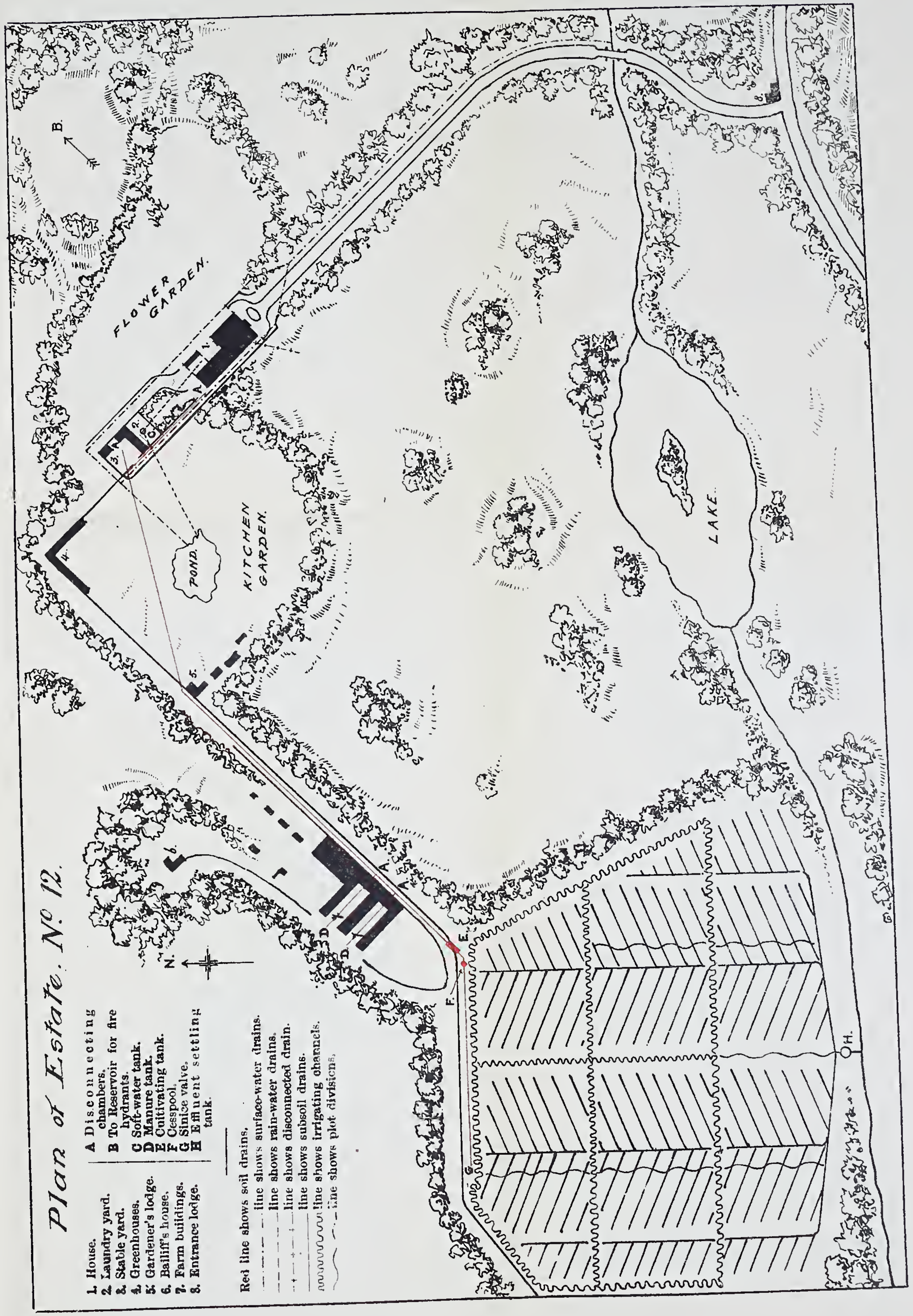
13. Grease gulley.
14. To sewage tank.
15. To rain-water tank.
16. Inlet to rain-water tank.
17. Position of main surface water drains, Pars. 180, 192.
18. Disconnected drain from cellars, Pars. 189, 194.

Block Plan showing drains No. 11.

Scale of 10 0 10 20 30 40 50 60 70 80 90 100 Feet.



Plan of Estate. No. 12.

1. House.
2. Laundry yard.
3. Stable yard.
4. Greenhouses.
5. Gardener's lodge.
6. Bailiff's house.
7. Farm buildings.
8. Entrance lodge.

A Disconnecting chambers.
B To Reservoir for fire hydrants.
C Soft-water tank.
D Manure tank.
E Cultivating tank.
F Cesspool.
G Sluice valve.
H Effluent settling tank.

Red line shows soil drains.
line shows surface-water drains.
line shows rain-water drains.
line shows disconnected drain.
line shows subsoil drains.
line shows irrigating channels.
line shows plot divisions.

REPORT OF

The Lancet Special Commission

ON

THE WATER SUPPLY AND DISPOSAL OF SEWAGE IN RURAL DISTRICTS.

INTRODUCTION.

THE Report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work, published in THE LANCET of July 4th, 1896, and subsequently reprinted in pamphlet form and extensively circulated, met with such favourable acceptance that it has been deemed expedient to extend the inquiry.

Nature of Inquiry.—The former Report dealt only with town houses, where it was assumed efficient systems of public water-supply and drainage existed. It is, however, only too evident that in rural districts where no such provision exists there are a very large number of houses more or less isolated which are most inadequately provided for in these respects, and indeed are surrounded by most insanitary conditions. It is with these that the present Report deals.

The Extended Nature of the Inquiry renders it impossible to avoid taking into consideration questions that are only remotely related to the plumber, and one of the principal difficulties is to confine the discussion of these collateral subjects within reasonable limits. It must therefore be borne in mind that the object in view is to give a general outline only of the leading points.

The Importance of the Subject.—The great importance of an adequate provision of pure air and water and the influence which they exercise upon the physical and moral well-being of a people are so well known that it would seem at first sight unnecessary to call further attention to the subject. That this is unfortunately not the case the annual death-rate from preventable diseases bears a melancholy testimony.

Preventable Disease.—The mass of avoidable misery and suffering borne by thousands through the neglect of sanitary laws should surely enlist the sympathy and assistance of all. Among the preventable diseases which may be regarded as connected directly or indirectly with defective drainage or polluted water are enteric fever, cholera, diphtheria, and diarrhœa; of puerperal fever alone some four thousand deaths occur annually, and undoubtedly a certain proportion are attributable to insanitary associations. Minor ailments, such as sore throat, indigestion, headache, and a general depression of vital force, are of frequent occurrence and may often be ascribed to similar causes.

The Economic Aspect.—At the monthly dinner of the Article Club held at the Hotel Cecil in March, 1898, an after-dinner discussion on the Price of National Health was introduced by Mr. Wolf Defries, the chairman. Mr. Defries said that notwithstanding modern progress in sanitation and public health matters, among males in 1895 the six principal zymotic diseases accounted for nearly 8½ per cent. of the total mortality of the country, while tuberculosis accounted for 11 per cent. more. The minimum value of a life had been calculated by Dr. Farr at £159 per head for lives of all sexes and ages calculated on the basis of the average earnings of the agricultural labourer, from which the cost of his keep was deducted. Adopting this figure Mr. Defries showed that the country had lost in a single year—1895—£17,000,000 through preventable disease.

Instances.—The outbreak of cholera in the east of London in 1866 was properly considered by Dr. Netten Radcliffe to have arisen from the consumption of water taken from the polluted Lee.

The outbreak of enteric fever at Worthing in 1893 was traced to contamination of the water-supply by leakage of fæcal matter from the drain passing through fissures in the chalk into the well, a conclusion which was supported by Dr. Klein's bacterioscopic examination of the well water. The necessity for a frequent and regular bacteriological examination of any public water-supply, in preference to a merely chemical one, is well exemplified in this instance. Upon this outbreak Dr. Theodore Thomson reported that several chemical analyses of Worthing water, taken before as well as after the date on which the new supply was utilised, failed to detect any definite impurity in the water. It was also reported by Dr. Dupré that previously to the outbreak Professor Crookshank made two bacteriological and three chemical examinations with negative results.

The outbreak of cholera at Hamburg was traced by Professor Koch to pollution of the water from an infected vessel in the harbour combined with a defect in a filter at the waterworks. In fact, most of the epidemics within recent years of enteric fever, cholera, or diarrhœa have been traced to either the water-supply or to defective drainage, the defects in the former being frequently caused by some defect in the latter.

Cholera at Altona.—As an instance of the liability of defectively planned sanitary appliances to become a source of danger to life when surrounded by other than normal conditions, the outbreak of cholera in Altona in 1893 in a poor district named Ottensen may be given. Some of the houses were supplied with water from a well having a wooden top covered with earth and stones. Owing to the frozen state of the ground and gullies some badly polluted refuse water escaped over the surface instead of entering the drain and percolated into the well. Other houses in the same district not using the water from this particular well escaped infection. In the previous summer, when Hamburg suffered so severely from cholera owing to the polluted water-supply, this district, with the exception of two cases (one known to have been imported), was free although using the well. The sanitary surroundings were in a very unsatisfactory state. The same lesson is taught by every fresh outbreak of disease, yet but little impression is made upon those in other districts where exactly similar insanitary conditions prevail.

Apathy of the Public arises from general indifference, a dislike to any alteration in the existing arrangements, coupled with an ever-present difficulty in all questions—viz., that of cost. No doubt of late years the depression in agriculture has formed an additional barrier to rural progress in these matters. To these causes may be added the fact that with most defective surroundings those in occupation frequently continue for a lengthened period without suffering any marked decline from a normal standard of health. The chance addition of some one untoward factor, a stopped drain diverting a flow of sewage or a severe frost fracturing the side of a reservoir, may be the immediate cause of an epidemic.

Local Waterworks.—It is, however, satisfactory to know that there are exceptions to this spirit of apathy, and there are in some places land-owners and others, members of parish councils or rural district councils, who are fully alive to the importance of these questions. It is such men, generally in the face of much opposition, who avail themselves of the powers conferred by the Acts of 1875, 1878, and 1894 to establish waterworks on a small scale for the supply of their own and their neighbours' houses in cases where the individual supplies are known to be defective.

Water Analysis.—Too much reliance must not be placed upon an analysis of any water intended for drinking, for water taken from the same source at different seasons may vary in a most remarkable manner. Dr. J. C. Thresh, medical officer of health of the Essex County Council, indeed, states that he has in two samples taken from one well at the same time, but at different depths, found very different results. Heavy rains materially influence water by washing various substances into the source from which it is taken.

In submitting a sample for analysis the vessel intended to hold it must in the first place be scrupulously clean and be fitted with a clean cork or, what is better, a glass stopper. It is well also to rinse it often with some of the water to be tested. After collection it should be submitted to the chemist with as little delay as possible. It is always impolitic, not to say unfair, to the analyst not to furnish him with the very fullest particulars of the source and its surroundings from which the sample is taken for this reason. An excessive amount of albuminoid ammonia or free ammonia might not condemn the water if their presence was known to be due to vegetable decay, though the same would be considered highly dangerous if the pollution arose from an animal source, though, of course, any excessive quantity must always be regarded with suspicion. Again, the absence of these substances is no conclusive proof of the safety of a water for dietetic purposes. Also the amount of chlorine in any sample, although it might indicate original organic pollution, need not of necessity condemn a water as the organic matter present originally might have become completely oxidised, the amount of chlorine remaining constant. It must, however, be remembered that local inspection of the source of supply is the only satisfactory method of estimating the risk of pollution to which such supply is liable.

Bacteria.—Again, should a bacteriological examination reveal any specific pathogenic organisms all doubt would at once be at an end, but when the search for them has been compared to that for the needle in the proverbial haystack their non-discovery is hardly conclusive proof of their absence Professor Koch lays it down as a working axiom that any water that holds more than 100 bacteria germs capable of development to the cubic centimetre is unsafe for drinking. This seems to leave the odds rather in favour of the enemy, but when Professor Pfuhl speaks of having counted as many as 302,400 germs in one sample c.c. the 100 or less may be accepted in a spirit of thankfulness. There would seem good reason to believe that certain micro-organisms always present in fæcal matter may, under some conditions, assume a pathogenic character.

Dairy Farms.—A knowledge of the many opportunities for the pollution of a water-supply gathered from cases that have been reported upon from time to time makes it evident how much remains to be desired. Especially is this the case with regard to the water-supply of dairy farms, which requires careful supervision. As an illustration of want of observation on the part of an inspector and the little reliance to be placed upon water analysis the following is given. A man, thirty-six years of age, was taken suddenly with gastro-enteritis; being placed upon a milk diet the symptoms rapidly became aggravated. The milk food was stopped and barley-water alone was given for forty-eight hours with marked improvement, only to be followed by a relapse on a return to milk food. The milk was again suspended with relief to the patient, but still it was not suspected, as others in the house were taking it in tea without ill effect; but when the milk was tried by the patient for the third time the connexion with the symptoms became too apparent. A change in the source of the milk-supply at once moderated the attack and a rapid and uninterrupted recovery was made. An examination of the premises from which the original milk was obtained revealed a shallow well in close proximity to a graveyard with a loam and gravel soil. The water from this well had been used for washing the milk cans. These premises had frequently been examined by the local sanitary inspector and presumably the nearness of the well to the graveyard had never occurred to him, though, as a matter of fact, they were only divided by a high wall. A few months prior to this occurrence an analysis had been made of the water with satisfactory results, but a second examination showed it to be highly contaminated. The first was made after dry weather and the second after wet. Several other cases of illness occurred in patients using milk supplied from this farm and the well was closed.

The Country Plumber.—The plumber is to a very large extent the master of the situation. This reflection possibly is not calculated to afford much consolation, more especially to those who are familiar with him in what may be termed the wild state. His opportunities for improvement have been limited, while frequently the little technical knowledge which he possesses impresses him with his own notions and bars his further progress. There are, of course, many exceptions, but the good man is as a rule drawn to the towns. When his powers for evil are contemplated a more than usual interest in his proceedings is engendered. What matters the original purity of water in a well if the plumber fixes the suction-pipe in such a manner as to allow foul surface water to flow back round the outside of the pipe into the well and pollute it? It is therefore of the greatest importance that the plumber should receive every encouragement for his improvement, as without doubt he occupies a most responsible position.

Should any considerable sanitary alterations be contemplated on a property doubtless an architect or other competent person would be consulted. In the majority of minor cases it is the local jobber, possibly a blacksmith or carpenter by trade, who makes what he considers the necessary alterations. Under these circumstances the desirability of keeping the water-supply and the sanitary arrangements as distinct as possible must be apparent to all. The plumber is, however, the man to whom attention must first be directed. Thousands of them, more or less competent, are at work in country places at the present time and it is no exaggeration to say that the result of their labours means health or sickness, life or death, to a vast number. The great difficulty is how these men are to be reached.

Plumbers' Registration, so as to ensure some measure of competency and control, offers the readiest means of grappling with the question. The Bill recently introduced into Parliament is most certainly deserving of more consideration than has hitherto been bestowed upon it.

Medical Officers of Health.—In the previous report it was suggested that the public were being educated to a right appreciation of this subject by the medical profession. Medical officers of health must still be considered our sheet-anchor and to them the public must look for any improvement and should yield them loyal support. There are many districts which active medical officers have made centres of light and learning in these matters and where their efforts have wonderfully reduced the local death-rate. It is desirable that these officers should wherever possible be free from the trammels of private practice.

Combined Drainage.—The law relating to easements is also one of great difficulty and at times a source of danger to the public health in growing districts. One cesspool is frequently shared by two or more properties and where alterations or additions are made to these buildings most undesirable complications not infrequently arise.

A common case is where the owner of a plot of land builds a row of cottages and drains them all into one cesspool in the garden of the end house. These houses in time are sold or let on leases with the usual covenants, including one for easement.

The lessee of the end house in this case has to keep his cesspool emptied to allow the contents of his neighbours' drains to escape. When a system of public sewers is introduced the lessee cannot connect his house into the new sewer and remove the cesspool until he has first drained into the sewer each of the houses connected with his cesspool. The result is that all these connexions with the public sewer are delayed, the unfortunate lessee paying the sewer-rate for each of these houses while retaining the cesspool and postponing, perhaps, the considerable outlay required from him.

Sanitary Inspectors.—One of the principal obstacles to progress in country districts is the insufficient emolument frequently offered to candidates for these most responsible posts. The poor remuneration, combined with the multifarious and often incongruous duties they are at times expected to perform, forms a barrier to commanding the services of the most able men.

District Councillors.—Speculating builders are frequently members of vestries and parish councils. They naturally seek to have a voice upon questions affecting new roads, rates, and many other matters in which they are more personally interested than most of their fellow parishioners; their influence, however, is not always for the general welfare where sanitary questions are concerned. The position of a conscientious sanitary inspector is often one of great delicacy in connexion with property held or erected by these members, the servant finding it difficult to take action against one of his masters. There are, however, cases where the presence of a builder upon a district council or vestry is a distinct gain. The individual interests of those in authority, in small districts in particular, greatly retards any advance towards a state of sanitary efficiency. A covers his garden with stables or keeps pigs; B runs the drainage from a row of houses into one cesspool in the end house in order that he may squeeze in an extra house in place of having them semi-detached, and it will be hard if C and D cannot find some way of making themselves a nuisance to their neighbours also. The result of this is that redress is most difficult to obtain. The sanitary inspector, generally a native, follows the lead of those who should set a better example. A, B, C, &c., are afraid of each other and look over these shortcomings by mutual agreement, well understood if not expressed. Here, again, the only hope rests with the medical officer of health.

Sewage Disposal: Water-carriage. — The water-carriage system has drawbacks and grave defaults are alleged against it, but it is the readiest if not the only method for the removal of excrement under the conditions of urban life. In the matter of sewage treatment we may expect to learn much from the Royal Commission now sitting on the subject.

Judging from present knowledge it is from some form of biological filter that deliverance from the difficulties connected with sewage disposal is to be expected. It is to a more natural system that attention is now being directed, for the use of chemicals is at best but an attempt to arrest a natural process, and by so doing the assistance of those forces of nature so beneficent as allies is lost, while an effluent is obtained unsuited for purposes of irrigation.

The Dry System.—If conformity with natural laws and the practices of antiquity are accepted as guides, then without doubt where circumstances permit the dry earth system is one that deserves most careful consideration. The great difficulty to be contended with in all systems of sewage disposal is the utterly listless, almost criminal neglect shown in regard to all matters of this nature by the bulk of the population. Any attempt at a general application of dry earth-closets most frequently results in disappointment, owing, firstly, to an erroneous impression on the part of local authorities that they will receive adequate attention from the individuals who use them; and, secondly, to the want of a scientific application of the dry methods where such have been adopted by sanitary authorities. At present the land to which the excreta are carried is usually too far from the points of collection. The large pails, intended to hold a week's output from each closet, are unwieldy, weighing when full some 180 lb. Their size renders them insanitary and repulsive, while their removal is both laborious and expensive. The amount of land frequently devoted to the purpose of reception is needlessly large. Recent experiments have proved that a plot of land of 600 square yards, equal to about one-eighth of an acre, is sufficient for the disposal of the excreta of 100 persons per annum. The more central and the nearer the vicinity of the plot to the houses the less will be the expense of removal and the better the results obtained. By the adoption of some form of dry catch such as described (pars. 144 and 209), in place of the pail and by a system of daily collection one man with a hand truck would be capable of more efficient work than two men with a horse and trolley as at present. With the dry catch much of the liquid portion is evaporated, and the remainder being absorbed by the earth the contents of the catch cease to be sloppy, the weight being materially decreased. The almost universal but absurd custom of burying night-soil deeply entirely defeats the object in view—viz., its rapid conversion into mould whilst the practice adds greatly to the risk of polluting the surrounding water-supplies. Night-soil so treated will be found at the end of many months still in its original foul condition All such burial must be quite superficial—in fact, merely covered with earth. When this is done it will at the end of three or four days be scarcely—if at all—distinguishable from the surrounding earth. As a manure it may be said that fresh human excreta is unparalleled. Prejudice and the inherent slowness of the pastoral mind to assimilate ideas other than those acquired in early youth will probably contribute to the long-continued use of the inevitable leaky drain and cesspool. Indeed, it were vain to expect otherwise. The adoption of a well-planned system of dry disposal by one of our large rural military depôts where such could have a fair trial might not only form a valuable object lesson to the country, but would afford excellent training to the troops in the event of active service in the field.

In place of any outlay upon main drainage and sewerage works necessitating the acquisition of considerable tracts of land for sewage farms, which last are not infrequently inadequately administered, an organised system for the daily supply of earth and for the removal and disposal of the contents of a suitable form of earth-closet would often be found more economical and sanitary. Notwithstanding the evils of the open cesspool system, with its many possibilities of water pollution, it is open to question whether the universal application of a regular drainage system in rural districts—always bearing in mind defective drains and fittings, the vagaries of the so-called plumber, and the popular belief that a water-closet is a suitable receptacle for any odd refuse—may not at times be attended with equally injurious results.

Water supply.—An efficient system of drainage and the adoption of more natural methods for the disposal of sewage than commonly prevails is the first step to command a supply of pure water. In selecting a source for a water-supply ordinary common sense on the spot, when used, is mostly to be preferred to scientific knowledge at a distance. The wish to shift a responsibility on to other than our own shoulders and the glamour attached to any special knowledge in which we do not participate often induces us to think otherwise. The inquiry tends to show that, in most cases where there is no public supply and in some cases where there is, tube wells are the most wholesome and readiest source for a supply, though these are not wholly free from risk, yet when the tube passes through an impermeable strata the risk is reduced to a minimum. Rivers and lowland streams are, on the other hand, the most objectionable as being most liable to contamination and such water should never be used unless most efficiently filtered. In cases, however, as in the supply of large towns, much more care should be exercised than generally prevails to prevent fouling above the intake. Pending a development of the question of the London water-supply an infinitely purer water might be secured for London and other riverside towns if the Conservators of the Thames and the Lee were in a better position, both legally and financially, to detect and control the pollution of the rivers under their charge.

Old Country Houses are frequently worthy monuments of the artistic skill of the architects and the integrity of the builders of past generations. It would be little to the credit of their descendants if, fired by a new-born zeal, they disfigured their buildings with forests of unsightly ventilating pipes. Where difficulties in this respect present themselves the opinion of an architect should always be sought.

Plan of the Report.—A somewhat different system has been adopted from that of the previous report, it being found impossible to include all the necessary illustrations under a few examples. The subject is discussed under heads and the several sources of water-supply and the causes of possible pollution are taken in detail. To this is added a description of the means usually adopted for the disposal of the sewage.

One example only is given of a country mansion, but this is made to embrace a farmhouse and one or two cottages; the difference in treatment here is rather in degree than in kind. The question of efficiency has alone been dealt with, it having been found undesirable to offer any nearer approximation of prices than those already published for the town houses. This is owing to the fluctuations in the cost of labour and materials in different localities, the varying distances from towns or railways affecting the cost of cartage, &c. This may be roughly calculated at 10 per cent. advance upon London prices.

Results of the Inquiry.—The practical lessons to be drawn from the inquiry are briefly these: 1. To educate and register those employed as plumbers. 2. To bestow upon medical officers of health and borough surveyors a larger measure of independent authority than they at present possess, the interference by members of parish councils or vestries in purely technical questions being frequently attended with disastrous results. 3. The higher remuneration of rural sanitary inspectors with a view to attract more able men for the position. The same may frequently be said of borough surveyors. 4. The use of some simple form of biological filter, or the adoption of the best system of sewage treatment in all cases where the water carriage system is in use. 5. The great advantages possessed by the dry system for small or medium-sized properties for the disposal of excreta, the use of water carriage in these cases being at present almost invariably associated with cesspools and tending to soil and water pollution. 6. Additional care in the selection of water-supplies and greater regard for their protection from pollution together with provision for frequent inspection. 7. The little reliance to be placed upon any one analysis of water as conclusive evidence of its suitability for dietetic purposes and the great importance of local inspection in all cases.

THE REPORT.

1. In an investigation into a subject which, though mainly confined to plumbers' work, must of necessity touch upon most matters that relate to the sanitary condition of country houses, the difficulty of deciding what shall or shall not be included is great. The position of a house, the nature of the soil, its vicinity to water and trees may seem at first sight somewhat remote, but they influence considerably questions of water-supply, damp, and drainage. The internal plumbers' work in principle will be the same as described for town houses, but varied to meet the requirements of each case.

2. In a country house all drains connected in any way with a soil drain must be kept outside the building.

3. Water-supply will first be dealt with as briefly as possible. That this should be abundant and good in quality is one of the first essentials.

The desirability of various sources of water for domestic use are generally classed somewhat in the following order of merit :—

(1) Upland surface water after settlement in a lake or reservoir, as this water is generally impregnated with earthy matter.
(2) Deep well water from the chalk or greensand.
(3) Rain water collected on a properly prepared and enclosed ground.
(4) Land springs.
(5) Rain water collected from roof.
(6) River water.
(7) Shallow well water.
(8) Surface water from cultivated ground.

Nos. (5), (6), and (8) may be considered as extremely dangerous for dietetic purposes without previous treatment. No. (7) can only be used with safety where proper provision is made to exclude all surface or contaminated water.

4. The table given in the following paragraph on water-supplies and mortality from fever would at first glance seem to modify the above statement, but it must be remembered that the high place taken by river water as represented by London is owing to the very efficient system of filtration to which it is subjected and also to the sanitary surroundings of a large proportion of the people. Upland and moorland supplies are, on the other hand, very low down in the scale, owing in a very large measure to the defective sanitary condition of certain of the poorer districts.

5. *Water-supplies and Mortality from Fever.*—Mr. A. H. Smee, M.R.C.S. Eng., F.S S , Chief Medical Adviser to the Gresham Life Office, in writing to THE LANCET, March 13th, 1897, gives the following. The table is the result of his investigations into the variations of the death-rate from enteric fever in several towns drawing their water-supplies from different natural sources. The calculations relate to the year 1896 and are taken from official Government statistics. The whole is of such interest that it is given *in extenso*. He says :—

"For comparison and to avoid decimals I have computed the mortality from fever per 1,000.000 living from a few typical towns the water-supplies of which are drawn from widely different sources.

Rivers and Chalk.

London	137	Paris	110

Chalk.

Lemberg	288	Epsom (mean of last ten years)	190
Rouen (and Wells; three-quarters of a year)	282	Portsmouth	153
Hull	280	Rheims	131
Norwich	193	Brighton	118
		Lille	70

Upland and Moorland.

Belfast	550	Birmingham (and wells in red sandstone)	214
Dublin	453	Leeds	213
Liverpool	322	Leicester	202
Sheffield	298	Brussels (and wells)	190
Manchester	229		
Glasgow	223		

Sand and Sand Lakes.

Copenhagen	74	Amsterdam	28
Berlin	65	Ghent	91
The Hague	38		

Limestone Water.

Linz	277	Gratz	101
Prague (and River Moldeue)	214	Pilsen	91
Liége	117		

Filtered River Waters.

Magdeburg	84	Dresden	42
Hamburg	58	Frankfort	42
Cologne	49	Altona	41

Snow Water Lakes.

Zürich	104	Geneva	51
Lausanne	82		

Mountain Water.

Nuremberg	42	Munich	32
Vienna	40		

Other Sources.

Malines (shallow surface wells)	993	Charlottenburg (ground water freed from its ferruginous matter by process of exposure to air)	87
Antwerp (river water treated by iron filtration and shallow wells)	154	Bristol (red sandstone)	79
		Dorking (greensand; mean of last ten years)	70

It will be observed that towns drawing their water-supply from sands, melted snow, and rivers have a lower rate of mortality from fever than those drawing their supply from either chalk, peat, or moorland gathering ground.

"Dr. Seaton, the county medical officer of Surrey, has shown in his report on water-supplies that the mean death-rate from enteric fever for the last decade for Epsom and Sutton, which obtain their water-supply exclusively from the chalk, was at the rate of 190 per 1,000,000 living, and that this rate was an increase over the mean death-rate of the previous decade. The mortality from fever at Reigate, another chalk supply, was 160. On the other hand, Dorking, which formerly derived its water from the chalk, but now obtains its water from greensand, had a mean death-rate of 70 per 1,000,000, and shows a material diminution in the death-rate from this cause. In Chertsey, which derives its supply principally from the Thames, the mean death-rate from typhoid fever was 90 per 1,000,000 during the same period. ...... I trust that I have made out a *primâ-facie* case for an exhaustive Government inquiry as to the cause of the susceptibility to and immunity from fever amongst populations deriving their water-supply from various sources. Moreover, it is at least open to discussion whether municipal bodies, who are empowered to levy rates for sanitary administration, are suitable authorities to act as amateur managers of trading monopolies.''

6. Before dealing with each of these various sources of supply in detail an enumeration of some of the principal causes of pollution to which they are liable may, in order that they may be guarded against, be briefly summarised under two heads :—

(1) Pollution prior to delivery into the house of the consumer.

(2) Contamination on the premises.

7. POLLUTION PRIOR TO DELIVERY INTO THE HOUSE OF THE CONSUMER.

(1) From sheep and cattle pastured on the gathering-ground or having access to the spring head or reservoir.

(2) Dead animals in such situations.

(3) Dogs entering reservoir.

(4) The solvent action of the water on the pipes used to convey same to house (see par. 43).

Note A.—Water charged with peat has an exceptionally rapid action upon lead owing to acidity produced by the action of certain bacteria in the earth through which it passes. It requires special provision in filtering through limestone before passing into lead pipes.

(5) The tow used in caulking the joints of iron mains (see par. 41).

(6) The house refuse of any outlying cottage on the banks of some tributary stream.

(7) Through the leakage of surface-water into the storage reservoir, either over the top or through the sides.

(8) Or by the insuction of foul water into the supply-pipe from some defective drain, cesspool, or from the surface drainage of the land.

(9) By the percolation of sea-water into wells, particularly in times of drought owing to the lowering of the water in the well below the sea-level, as recently occurred at Eastbourne.

(10) Small animals often fall into wells open at the top, together with dirt and surface drainage.

(11) Subsoil water enters shallow wells through the sides

from adjacent drains, graveyards, manure heaps, cesspools, middens, especially in a porous soil.

(12) Through rat-runs between wells and drains, admitting foul air or overflow water.

(13) By men employed in digging wells, or in enlarging the bottoms of existing wells, or in fixing deep well-pumps.

(14) Foul water frequently enters wells following the course of the suction pipe.

(15) Rotting wood used in the construction of wells encourages wood-lice, &c., and fungus.

(16) Surface drainage is carried into springs and wells through fissures without having first filtered through the soil. In limestone districts water will travel in such fissures for long distances.

(17) Through the brickwork and new cement used in forming reservoirs, particularly if road-drift is used in place of sand.

(18) By leaky gas mains.

(19) In rivers and streams—manure from cultivated lands is washed in by rain.

(20) Many drains discharge sewage and factory waste into ditches that feed the streams.

(21) The refuse of houseboats and barges often thrown into rivers.

(22) By dead bodies of men and animals.

(23) By decaying wood and vegetable matter.

(24) By men, cattle, and dogs bathing.

(25) By gipsies and others camping out and washing clothes and foul linen in river.

(26) By dead birds and dead fish and refuse of picnic parties.

Most of the foregoing will be greatly aggravated in times of flood.

8. CONTAMINATION ON THE PREMISES.

(1) Cisterns without covers not only admit dirt, but mice, birds, and the remains of household pets are occasionally found in them.

(2) Ventilating pipes frequently terminate close to cisterns or their overflows or under the open eaves of the roof where cisterns are fixed.

(3) Air pipes from service boxes in cisterns supplying both closets and sinks.

(4) By waste pipes directly connected with soil drains.

(5) By broken cistern lids and felt used as a protection against frost falling into cistern.

(6) Service pipes laid in same trench with drain offer risk of insuction of foul water.

(7) By service pipes crossing under or over drains, unless especially protected.

(8) Rain water collected from a roof is liable to extra risks from soot, tame pigeons and wild birds large and small, their nests, also cats.

(9) Dead leaves and accumulation of dirt in gutters, particularly in trough gutters running from back to front inside roof.

(10) The dirty and indolent sometimes throw bedroom slops and rubbish into gutters from attic windows.

(11) Gutters are fouled at times by sweeps and other workmen.

(12) Neglected filters.

(13) Dirty sinks, especially housemaids' slop sinks, the taps of which are liable to be splashed by slop water, or have dirty house-flannels laid on them to drain often just prior to filling the drinking-water bottles.

(14) From insuction where there is an intermittent supply.

Note B.—Plumbers frequently fix in cisterns that are near sleeping-rooms a pipe on to the end of the ball valve to carry water to bottom of cistern without noise. When water is drawn from the main at a lower level this pipe acts as a syphon and will suck back the water into main from cistern, including of course any dirt that may be in the cistern at the time. Very serious cases of insuction have been recorded, including one from a public urinal.

Labourers are commonly deputed to clean out cisterns, their boots and clothes are frequently defiled by working in old drains and in removing old soil-pipes.

(15) Water becomes polluted in cisterns placed in or over water-closets, also under floors of bedrooms and in sculleries and other places to which drain air may find access.

(16) *Underground* cisterns may be contaminated by defective drains and surface-water and are liable to damage by frost.

(17) From dipping dirty bowls, &c., into cisterns and storage tanks.

(18) From the action of water upon metals, as lead, galvanised iron, or zinc, used for cisterns or pipes, lead flats, or gutters

(19) Through the use of dirty mops or brooms in cleaning out cisterns.

SOURCES OF SUPPLY.

9. *Moorland or Upland Surface Water.*—In order of initial purity we have "upland surface water." This generally forms the source of supply in mountainous or moorland districts, where the rocks are either igneous, metamorphic, or are formed of hard millstone grit. The thin soil does not admit of cultivation, and is used only for the pasturage of sheep. The organic pollution from this source may be reckoned almost *nil*, for, unlike the lowlands, where so many sheep are allotted to each acre, here so many acres are allotted to each sheep. Occasionally one may die and decay in some out-of-the-way spot, or even fall off a rock and be drowned in a torrent bed. Even this is not such an important matter as might at first sight appear, for water that falls over rough and broken ground is very rapidly oxidised.

10. The town of Torquay, which draws its supplies from Dartmoor, has recently spent a considerable sum of money in obtaining the right to, and in enclosing, the watershed from which its supply is derived. It frequently happens that water drawn from such a source is heavily charged with peat or earthy matter and occasionally with iron, in these cases a subsidence reservoir is desirable. As already mentioned, water charged with peat acquires a considerable amount of acidity, which acts very rapidly upon metals, particularly upon lead, this action may be obviated by saturating it with carbonate of lime, which is done by passing it through a limestone filter, the only objection to this being that it adds considerably to its hardness. The experience gained from Yorkshire and other places using moorland water, should exclude the use of lead pipes (par. 43). Water containing carbonates forms a coating of carbonate of lead inside the lead pipe, which being insoluble in water prevents any further action taking place. Of course, being dependent upon such a source for a supply a reservoir is a necessity (see pars. 53 to 62).

11. The following is a digest of a short table recently published by the Meteorological Office of rainfall during the past twenty-five years :—

Approximate Average Annual Rainfall.

England and Wales.	
North-east	26·50 in.
East	26·00 ,,
Midlands	28 00 ,,
South	29·00 ,,
South-west	40·40 ,,
North-west	36·60 ,,
Ireland.	
North	38·60 in.
South	39·00 ,,
Scotland.	
North	52·00 in.
East	32·00 ,,
West	50·00 ,,

12. It will be noticed that the annual rainfall varies considerably in different parts, but is usually heavy in the western counties and in elevated situations. The best way to form a calculation is to take an average of the fall in any three consecutive dry years, which will very likely amount to some 30 in. The general average would be much more, but this will probably be carried over the reservoirs in times of excessive floods. The quantity collected will prove to be considerably less than the rainfall, as it is affected by the nature and inclination of the rocks, the amount of vegetation, and the evaporation. Evidence has been given before a Royal Commission which would tend to show that this is a very constant amount and not dependent upon the rainfall, the average being about 13 in. The amount lost by evaporation from an open reservoir is about 30 in. in depth per annum over the whole surface.

13. *Deep Wells.*—Deeply dug wells are perhaps the next most frequent sources of supply. They are of course subject to the same risks of pollution as the shallow ones, with the addition of the possible entrance of contaminated water through fissures at a considerable depth. The outbreak of typhoid fever at Worthing in 1894 was from this cause, while the fact that fissures were present in the well supplying Eastbourne in 1896 is proved by sea-water having entered the well. This was in all probability owing to the drought in the early summer having caused the water in the well to sink below

the sea-level. It is impossible to exercise too much care to ascertain the exact character of water entering wells through a fissure, especially if situated in the neighbourhood of thickly populated districts, as water has been known to travel long distances through them without undergoing filtration; indeed many wells have had to be abandoned on this account. The subject of the geological formations which are most desirable as sources from which to draw a domestic water-supply and the character and quantity of water likely to be found in the various strata, though interesting and intimately connected with the subject, can be omitted, the opinion of an expert upon these matters being invariably taken prior to the appearance of the plumber on the scene.

14. The practice of boring at the bottom of a dug well in order to form a reservoir, as well as to obtain a position for the pumps, is now seldom resorted to. With the dug well, unless the upper stratum be an impermeable clay, iron cylinders must be sunk as far as is necessary to keep out the surface drainage, as in shallow wells, and this is frequently a costly process. In the "Tube Well System" the tube from the pump to the spring is a continuous one, and the pump itself is attached to the tube by an air-tight connexion. This removes the pressure of the air from the water in the tube. The velocity of the flow of the spring is also thereby greatly increased, the removal of the pressure of the air from the water in the tube being equivalent to a greatly increased head of water in the spring. If necessary, these pumps can be placed as low as 150 ft. or 200 ft. from the surface. There is one point which should always be kept in view—viz., that the tube throughout must be connected so that neither surface water nor sand may obtain access into it. The cost of boring such a well to the depth of from 200 ft. to 300 ft. would amount approximately to some 20*s*. per foot.

15. The publicity given by inquests held upon workmen who have lost their lives by descending wells in which carbonic acid gas has accumulated should deter others from running such unnecessary risks, but apparently such warnings are thrown away. In THE LANCET, Jan. 9th, 1897, an account is given of such a catastrophe in a well belonging to the Hastings Corporation which resulted in loss of life to one workman and nearly proved fatal to a second. The well was an open one some 60 ft. deep, lined with iron cylinders for 20 ft. down and with brickwork for the remaining 40 ft.

16. The common precaution of lowering a lighted candle into the well before descending had been neglected. It may be pointed out that it is only safe to enter a well when the flame of the candle burns with undiminished brilliancy and not only when it is not extinguished, as combustion may continue in air dangerously charged with carbonic acid. A well may be cleared of foul air by slowly lowering a bright fire in a perforated iron pail, when the heated air ascending carries up with it the heavy gas that has accumulated at the bottom, or a pail of freshly burnt lime saturated with water may be lowered, in which case the carbonic acid is absorbed.

17. In all cases where the supply is taken from a well pumps are necessary to raise and force the water into a reservoir or cisterns. The suction pipe should always receive particular attention, not only that surface water may not flow back round the outside of it into the well, but that the pipe is so supported and protected from injury in its course under the ground that no insuction of ground water may occur, such faults being very difficult of detection when they arise.

18. *Rain Water Collected from Artificially Prepared and Enclosed Ground.*—Rain water collected upon an artificially-constructed gathering ground is rather an expensive but a very satisfactory source of supply. Asphalt laid upon a concrete bed forms the best floor, the space necessary to devote to this purpose will of course be governed by the requirements of the establishment and the probable rainfall (see pars. 12 and 185). It is usually calculated from the fact that an inch rainfall yields some 22,622 gallons to the acre. It is most important that any artificial ground of this kind should be carefully fenced off, the lower part wired with netting sunk 2 ft. below the soil where it is turned outwards about 12 in. to exclude rabbits, and means must be adopted either by keeping the ground raised above the surrounding land or by forming a ditch round the same area to prevent the access of surface water.

Note C.—Rabbits in burrowing under any obstacle invariably sink a hole almost close to it and so come upon the buried wire; were it not that they were stopped by the horizontal piece forming a floor they would simply go down and under the vertical wire, but they seem to have no idea of working backwards so as to clear the 12 in. of flat wire.

19. *Land Springs.* — Where a house is so fortunately situated as to have a constant and reliable spring in its vicinity the water can be conducted to it by gravitation if the spring is at a sufficiently high level (see par. 56). If,

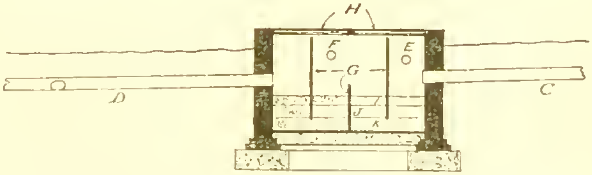
however, the house is higher than the spring, then it must be pumped up by means of a water-ram, a water-wheel, or a windmill (see pars. 46–49). Care should be taken to see that the spring is not fouled by cattle and small animals, or by drainage of surface water from the adjacent land. It should be railed round at least some 6 ft. from the edge, and the ground must slope away from and not towards it, as is more often the case, also as much as possible overhanging branches should be cleared from the trees that leaves may not fall into it. Should the spring be steady but small in volume an increased supply may frequently be obtained by opening up the spring head. It may, however, be found necessary to form a small reservoir (see par. 53, &c.), in which the water can accumulate in order to meet the extra demands made upon it at certain hours of the day ; a storage reservoir is not otherwise desirable, at least, so far as the domestic supply is concerned. From whatever source, however, a supply is obtained a quantity should be stored at a height sufficient to give the requisite pressure for the supply of fire hydrant (see par. 56), as it is essential that these should be fixed at various points. Mostly, if a country house takes fire, it is doomed.

20. A land spring being in most cases dependent upon similar conditions for its supply as a shallow well, the caution given respecting pollution (pars. 31, 32) should be borne in mind.

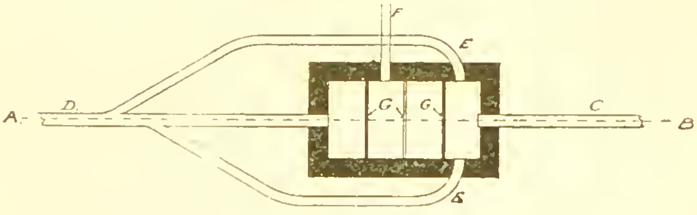
21. *Rain Water from a Roof.*—Frequently an abortive attempt is made to utilise the rainfall by the construction of a cistern in the roof, into which the water from the several gutters is conducted. The common mistake is that the space allowed for storage is too small ; the cistern is filled by the first shower, after which a much larger quantity runs to waste. The large area generally covered by the roof of a country house offers a favourable opportunity for the collection of a supply of soft water, valuable for the laundry or for personal ablution. Owing, however, to its liability to pollution during the process of collection it is an undesirable source for drinking-water, unless very efficiently filtered. One of the chief causes of pollution in water so collected is, that large birds, such as pigeons, daws, starlings, as well as smaller birds, constantly build in or upon the roof of a country house. In the case of a roof with dormer windows that open on to the leads and gutters it is a temptation to the careless and indolent to empty bedroom slops out into the gutters. That this is very frequently done the accu-

mulation to be found round the outlets to the rain-water pipe testify. Another danger is the liability of the water to absorb lead from the flats and gutters in its passage down the roof. Cats again are extremely fond of basking upon a roof, doubtless attracted by the seclusion and the chances of sport offered by the birds; their presence there is a constant source of pollution. The great advantages offered by a soft water for purposes of ablution and for use in the laundry make it most desirable to utilise the rainfall on the house roof wherever practicable. The roof of a large country house might be taken as an example, though it is equally desirable to collect it if only on a cottage. On a roof that covers 4000 ft. superficial area — not an excessive size for a country house — an average rainfall of 26 in. would yield a gross supply of 54,162 gallons. This, after 6 in. have been allowed for absorption and evaporation, an ample allowance on an ordinary roof, will give a net result of 41,662 gallons, or a daily supply for an average of fifteen persons all the year round of over seven gallons and a half per head. Where it is intended to utilise the rain water from a roof it is well to pass the water through some such rough filter as is shown in the illustration, Fig. 1,

FIG. 1.



Section A B



Plan of Rain Water Filter

which will occasionally require to be cleaned out and unless periodical cleansing is practised the filtered water may become more polluted than the unfiltered. A section is shown on the line A B. **C** is a 6 in. inlet pipe, **D** the outlet, **E** storm 4-in. overflow, **F** an air pipe between slate divisions **G**. **H** is a manhole cover, **I** 4 in. of coarse gravel, **J** 6 in. of fine gravel, **K** 6 in. or more of sand.

22. The next important point is where to store this large quantity of water. In the eastern counties the provision must be greater than is necessary in the western ones, where the rainfall is more regular. Not less than a four months' supply should be provided. Not only have long periods of drought to be considered, but in cases where the number of occupants varies from time to time it often occurs, if the tank is too small, that much of the calculated supply will be lost. In the present case it will be necessary to store 14,000 gallons. To hold this quantity a tank must be built having an internal measurement of 15 ft. square by 10 ft. deep; a circular tank is more readily made water-tight. If circular, the tank would be nearly 13 ft. deep. In most cases this has to be on, if not under, the ground, as the weight of water alone, over 60 tons, is too much to place upon any building unless especially prepared. Should this water be intended for cooking or drinking purposes it is far safer to have the tank raised slightly above the ground. If this cannot be done the same care must be exercised to prevent pollution as in the case of a well (see shallow wells, par. 33), or built as shown in Fig. 20. A large proportion of the roof of a country house is over the offices and built at a low elevation, so that if the water from them has to be collected the storage tank must be at a still lower level, and the water in any case must be pumped up to a supply cistern situated somewhere in the upper part of the house. The storage tank must be properly roofed over and efficiently ventilated: as far as possible, light should be excluded to prevent the growth of vegetation (par. 182).

23. *River Water.*—Rivers and streams that pass through cultivated districts are dangerous sources from which to draw a supply of water for domestic purposes as the surface water that they collect is usually heavily charged with all kinds of organic impurities. In addition to manure washed into them by heavy rains, gipsies and others commonly camp out near a stream. For example there are two or three spots on the Thames near London that will occur to the minds of many. One a little below the "Bells of Ouseley," one at

Walton, and another opposite the waterworks at Hampton. One very favourite camping-ground, where often large parties come to wash their foul linen, is by the One-mile Tree, midway between Kingston and Teddington. This last, however, is below the intake. Fortunately, in a large river like the Thames the risk is much less than would be the case in one of smaller volume.

24. It may be a picturesque sight to see some bare-footed Scotch girl stamping linen in a mountain stream, or a native of India swinging a shirt as though it were a blacksmith's hammer against a flat stone, but it is certainly a practice little conducive to the health of the unfortunates who drink the water lower down. One other source of pollution is the overflow or soakage from cesspools, and here again the Thames furnishes many examples.

25. At Sunbury, to mention one example, though happily now that a system of drainage has been completed there this source of pollution will cease, some fifty houses backing on to the river are each drained into one or more cesspools situated in the gardens. Some of the cesspools are but a few feet from the river's edge, which can be the only possible outlet for any overflow; this is much aggravated in times of flood. Again, on a small island just above the Broome-water at Teddington, during the summer from eighty to a hundred people camp, and this island, always saturated, being but little above the water line, is for this reason a most unsuitable soil to receive the excreta of such a large population and must greatly tend to pollute the river.

26. All of us who have hung on the bridge of some quiet village have felt saddened by the way in which these otherwise beautiful streams are outraged. More frequently than not they are used as the common dustbin for the village; old shreds of metal, rags of putrid clothes, and garbage of all kinds are freely flung into them. To quote the words of John Ruskin when writing in "The Crown of Wild Olives" of similar violation in the villages of Beddington and Carshalton :—

"I have never seen anything so ghastly in its inner tragic meaning—not in Pisan Maremma, not by the Campagna tomb, not by the Torcellan shore—as the slow stealing of reckless, indolent, animal neglect over the delicate sweetness of that English scene; nor is any blasphemy or impiety, any frantic saying or godless thought, more appalling to me—using the best powers of judgment I have to discern its sense and scope—than the insolent defiling of those streams by the human herds that drink of them."

Speaking of the inhabitants he adds:—

"They having neither energy to cart it away nor decency enough to dig it into the ground, thus shed into the stream to diffuse what venom of it will float and melt far away in all places where God meant those waters to bring joy and health."

Here, indeed, is an opportunity for the parish council or other local authority to benefit, not only their own village, but every other through which the same stream flows. There used to be, and probably there still are, villages in which a very primitive form of semi-public water-closet might be seen. It consisted of a long rail in lieu of a seat projected horizontally slightly over the stream, supported by means of some forked stakes. One of these villages suffered from a severe outbreak of typhoid fever in 1872.

27. It must be considered therefore highly dangerous to use water from such sources for dietetic purposes unless most efficiently filtered. The danger of such a source of supply has been well exemplified in the outbreaks of typhoid fever which have occurred more than once at Lynn, in Norfolk. The supply was drawn some few miles down from the spring head of a small stream which had previously passed through a district partly marshy and in parts highly cultivated. Local opinion, it is true, is or was divided as to whether this water-supply might fairly claim to have been the original cause, or whether it was not due to the defective state of the drainage of the town. Of course, in such a case it would be almost invidious to give too decided an opinion; but if only a part of the charges made against the drainage system are true it may be assumed that honours are divided, while the report of the Medical Department of the Local Government Board did not leave much doubt on the subject. The outbreak already referred to at Hamburg is another example. Without discussing the question at any great length an allusion to some of the points to which Professor Koch draws especial attention when writing upon water filtration may be of service.

28. Of sand filtration he says: "We are compelled to admit that even under the most favourable circumstances it cannot afford absolute protection against infection, though

it does afford a protection with which, considering the practical conditions of life one may rest content." He gives 30 cm. (slightly less than 12 inches) as the minimum depth for the sand layer; all dissolved matter passes through the filter. The most efficacious medium in the filter is the layer of slime deposited upon the top of the sand by the water, and this layer after a certain time, more or less according to the condition of the water and the number of bacteria present, becomes incapable of action. In summer water is particularly full of micro-organisms and this just at a time when most water is required; these clog the filter often in a few days. As a rule filters have not sufficient rest allowed them. When filtration becomes too slow this layer of slime must be removed, and until enough water has passed through to form a fresh layer of this material the effluent should be run to waste, an average of twenty-four hours being given as the time required to form this necessary layer. Thus it appears that it is one of the first essentials that this layer of slime should in no wise be disturbed while the filter is in action; this presents some difficulty as the entrance of the water, especially at first, is calculated to cause considerable commotion in the sand.

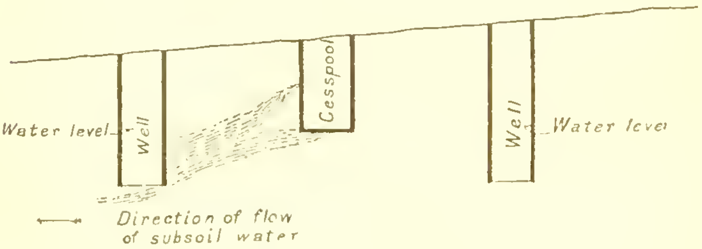
29. The rate of flow through the filter is another point that requires careful regulation. This rate is frequently calculated by a comparison of the quantity filtered in the twenty-four hours with the superficial area of the filter. Such a calculation is misleading, as the rate of flow will vary at different hours of the day according to the demands made upon the reservoir. Professor Koch gives as a maximum rate 100 millimetres per hour per square metre; he also considers that every three days the water should be bacteriologically examined, and when epidemics are imminent, or with open filters, in times of severe frost this should be done daily. In the latter case an exposed filter naturally would be rendered useless. As already stated filtered water containing more than 100 germs capable of development per c.c. should not be allowed to enter the pure water reservoir, and due provision for diverting such water should be made.

30. *Shallow Wells and Surface Water from Cultivated Ground.*—These are the commonest and in many cases the most polluted sources of supply. Their source is often surface drainage or shallow springs fed by the same. In small properties the well and the cesspool are often near neighbours. The soakage from the highly cultivated kitchen

garden, the farmyard, the manure heaps, and even at times the churchyard, all adds its quota to the water in the well, as on analysis the presence of free ammonia, nitrites, and nitrates, will frequently testify. Again, small and sometimes even large animals fall into wells that are open at the top. Rats have a faculty of burrowing straight to water and will frequently make a tunnel from the old drain in which they live to the nearest well and thus form a most undesirable means of communication between them. Where, however, due care is exercised in amending their construction shallow wells may be retained and they are capable of yielding a wholesome supply.

31. The depth from the surface to which it is necessary to render a well impervious to water will depend upon the geological formation and the level of the ground water. In a light sandy soil a greater depth will be necessary than in one of a heavier character. When the ground water-line is only a few feet from the surface the well should have an impervious lining to a depth of at least 9 ft. or 10 ft. The position which the well occupies in relation to any building or possible source of pollution is also of considerable moment. The flow of the subsoil water at any given point being always in the direction of the nearest natural outlet, when such exists—as a spring, stream, or sheet of water—it is evident that the purer water will be found before it passes such possible point of pollution. For this reason, in the case of two wells situated but a few yards from each other, one may yield a pure water and its neighbour one highly contaminated (see Fig. 2).

FIG. 2.



32. It should certainly be an absolute rule that no drain, cesspool, midden, or manure heap should be within, say, fifty feet of the well, and in a gravel or very porous soil

this distance should be exceeded. Again, the depth of a well affects the drainage area, for when the water in it is many feet deep the removal of this water by pumping has often a very far-reaching influence, in proportion, of course, to the density of the surrounding soil.

33. There are several ways of providing an impervious lining to a well. One is by forming a couple of single brick rings built in Portland cement and rendered on both sides in cement for a distance of some 10 ft. or 12 ft. below the surface of the soil more or less according to its permeability. This brickwork should be carried up to 12 in. above the ground level, care being taken to well puddle the space between the brickwork and the surrounding earth with clay. A second method is to reduce the opening of the well at the necessary depth with brickwork gathered over to support two or more lengths of stout cast-iron pipe 2 ft. in diameter, these to be fitted with caulked lead joints securely embedded at bottom and puddled with clay round the outside where it rests upon the brickwork, the ground round the well to be carefully rammed down at intervals, a few feet only being done at one time. There are to be obtained stoneware pipes for this purpose like enlarged drain pipes. When these are used they should be jointed in cement and puddled round the outside with clay as in the case of the brick rings.

34. It must, however, always be borne in mind that very severe frosts are liable to cause a fracture, and at such times the upper part of the well should be examined. Where good water is to be found at a depth not exceeding 150 ft., an "Abyssinian" tube-well will be found the least costly means to obtain a supply. They can be used to advantage in such soils as gravel, coarse sand, and chalk, but their use in clay soils, marls, or fine sand is not satisfactory. They cannot be driven through rock. The cost of such a well, say 100 ft. deep with a tube of 2 in. internal diameter, would be about £40. A well 20 ft. deep would probably not exceed £10, but this, of course, would depend upon the locality. Any well where the water is more than 25 ft. from the surface should be fitted with a deep well pump. There is far less risk of pollution in this form than in a dug well, provided the tube is perfect.

35. In some situations where a better supply of good water is obtainable at a lower level, an artesian well might be sunk at the bottom of the existing well, which can then be filled

up. Professor Koch, in his book on Cholera, advises, on economic grounds, that all shallow wells fitted with pumps in dangerous situations should be filled up, first with coarse gravel and then with fine sand, so as to form a filter bed; the sand in such cases should be 15 ft. deep, with the perforated end of the suction pipe bedded in the gravel. The level of the ground round all wells, more particularly dug wells, should slope from and not towards the mouth, to prevent the entrance of surface water. A good plan is to enclose them in a small well-house. The pump should be within the enclosure, with only the handle and the spout accessible from the outside.

36. Another plan, and for some reasons a better one, is to have the pump fixed some little distance from the well, the top of which projects above the ground and is covered by a large stone or iron joists and concrete cemented to render it watertight. In this case care must be taken with regard to two things :—

(1) That surface water cannot enter the well by falling back round the outside of the suction pipe.

(2) That should the distance from the well be considerable, the suction pipe must be of sufficient diameter to provide for friction in the horizontal pipe.

METHODS OF PURIFYING WATER.

37. *Domestic Filters.*—There are two principal actions that assist in the purification of water when passed through a properly constructed filter. The first is the mechanical straining of the solid particles present. The second is the oxidation of any organic matter by the atmospheric air contained in the pores of and the interstices around the medium used. Of the many filters that have been made those only dependent upon the efficient straining of the water are in any way reliable, and of these two only are known to be perfectly so, judging from a bacteriological standard. Most carefully constructed filters will, however, if constantly attended to, improve and purify water to some extent, but a neglected filter is worse than useless, fouling water instead of cleansing it.

38. *Boiled Water.*—For a private house dependent upon a doubtful source for its supply there is no protection equal to

that afforded by boiling the water for ten minutes. To do this without some special contrivance is both expensive, troublesome, and unsatisfactory, inasmuch as it imparts to the water a flat and insipid taste, and although it may render it safe it certainly makes it very unpleasant.

39. In THE LANCET of Jan. 2nd, 1897, an account was given of the Lawrence process of softening and sterilising water by means of a condenser. For domestic purposes in particular this apparatus, it is said, has the advantage of being cheap, light, very portable, and not liable to get out of order. It is made in various sizes to boil from 12 to 150 gallons of water per hour; it is easily worked at a small cost; and either gas, oil, or a coal fire may be used for heating it. After careful experiments it was found to yield excellent results, the water being perfectly clear and bright, palatable yet soft to the taste, while above all it gives absolute security against infection from any water-borne disease.

40. *Hard Water.*—It is scarcely necessary to dwell upon the desirability of the use of soft water in preference to hard. Economy, if nothing else, recommends it. There is a waste of two pounds weight of soap used in every 100 gallons of water that has 16° of hardness as calculated by Clark's process. Vegetables when cooked in it turn yellow and peas shrivel, but in soft water their colour is retained. Hard water compresses the pores of fresh meat boiled in it, while soft water has the opposite effect and acts as a solvent. The common cause of hardness in the water arises from the presence of bicarbonate of lime, also of sulphate of lime and sulphate of magnesia. Clark's process of softening water is the system commonly adopted by water companies who draw their supplies from the chalk. In pure water chalk is only soluble to a very slight extent, enough to impart some two degrees of hardness, but in water which holds free carbonic acid gas in solution 1 lb. of chalk can be dissolved in 560 gallons of water by 7 oz. of the gas. It is also soluble in water from an almost opposite cause—viz , by depriving the chalk of carbonic acid gas, as when it is converted into quicklime by heat. In burning 1 lb. of chalk 7 oz. in weight is lost by the loss of the carbonic acid gas driven off, the remainder, consisting of 9 oz. of quicklime, is then entirely soluble in 40 gallons of water. Clark's process takes advantage of this. The water to be softened which contains the 1 lb. of chalk per gallon is mixed with water containing 9 oz. of

quicklime per gallon, when the 7 oz. of free carbonic acid gas which held the first 1 lb. of chalk in solution combines with the 9 oz. of quicklime to form 1 lb. of chalk, and this together with the first 1 lb. of chalk now no longer soluble owing to the loss of the free carbonic acid gas is precipitated at the bottom of the tank. This process is convenient and simple enough when applied on a large scale, but it is troublesome to apply for private use. There are several domestic contrivances which take Clark's process as a basis. (See also pars. 28 and 29.)

WATER-MAINS.

41. All mains should be of cast-iron, and where placed on bad or made ground must be laid upon a cement concrete bed to avoid fracture by settlement and also should be protected from contact with brick or plaster rubbish containing lime which is likely to corrode the pipes. Where laid under roads they must be bridged over to prevent damage by heavy traffic. All mains should be kept at least 3 ft. below the surface of the ground to preserve them at an equable temperature. With long lengths of iron pipe it may be necessary to provide expansion boxes. In laying large cast-iron mains the joints are made by packing them with yarn and then running in molten lead, afterwards driving this home with an iron caulking tool; care is required that none of the yarn is allowed to get inside the main, and as little should be used in each joint as possible. Water passing through very long mains may become contaminated through the decay of the yarn used in the joints; for many reasons it is desirable to tar all mains internally to prevent rust. Dr. Angus Smith's is the process most desirable, the pipes being coated internally with a form of black enamel while hot immediately after casting. Owing to the large amount of oxygen present in very soft water rust will very often form in masses that greatly diminish the discharge from the pipes. Difficulties frequently present themselves in laying long mains owing to the contour of the ground, and levels in all cases must first be carefully taken. No loss of head will arise through the pipes following the contour line provided they do not rise above the level of a line drawn from the highest to the lowest point. This line is called the hydraulic mean gradient. Should they do so air will accumulate at this point and loss of head will result. It should not be forgotten that a slight loss of head is

caused by every bend in proportion as it is more or less acute. In deciding the size and thickness of iron mains the following points have to be taken into consideration: (1) the quantity of water required per minute; (2) the height of head; (3) the length of main for friction; (4) the height to which a jet of water is required to be thrown for fire hydrants. This last is greatly influenced by the size and shape of the nozzle used, the same head of water giving a jet greatly varying in height with different sized nozzles. It is impossible to offer in a few lines any general rule for guidance, as the several factors vary in almost every instance. With a little care by the help of a few good hydraulic tables the difficulty can be surmounted. The enormous loss of pressure by friction in long lengths of small pipes is a point too often lost sight of.

42. *Underground Waterpipes* in the vicinity of houses should be protected by being enclosed in a brick channel to prevent the risk of fracture when excavating at any subsequent time. They should never be laid in the same trench by the side of a drain, or cross one if it can possibly be avoided; should they do so they must be still further enclosed in a wooden trough filled in with pitch and be made to cross above the drain.

43. The use of lead pipes is most convenient for small mains and service pipes for house fittings, but the practice is one of too general application in view of the varying quality of the water in different localities. Iron pipes must be substituted for lead where the water is free from carbonates owing to the solvent action of soft water upon lead (see par. 10). Tin lined lead pipes found considerable favour for use with very soft water when they were first introduced, but owing to the fact that the lead was found to be acted upon by the tin they proved to be useless. The joints had to be made by means of brass connexions, and the tin lining having a much lower melting point (442° F.) than the lead pipe (617° F.) the soldering on of the brass connexions often leads to the melting of the tin. The cost of fixing also rendered it unsuitable for general use. More recently another endeavour has been made to overcome the difficulty by introducing a coating of asbestos between the lead and the tin, thus keeping the metals apart, while the non-conducting properties of the asbestos permit a plumber's ordinary joint to be made without melting the tin, but the risk from galvanic action between the tin and the lead remains.

44. In the use of iron pipes for hot water free from carbonates, as no fur is deposited on the insides of the pipes, the water is frequently discoloured by rust, being saturated with iron, so that in laundries, where a soft water is most desired, the circulating and service pipes should be of copper, or the clothes will suffer from iron mould. Where galvanised pipes are used the water becomes impregnated with the zinc, though after some little time this effect passes away.

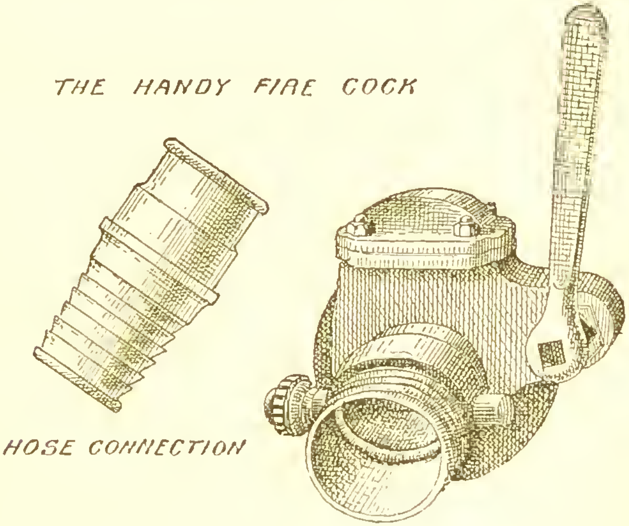
45. *Fire Hydrants* —It frequently happens that a house is dependent more or less for a supply of water in the event of a fire upon a lake or stream situated at a lower level; in this case the suction pipes should be laid to the most convenient points at which an engine could work, so as to save the delay and confusion likely to arise in laying a hose from a distance. In reference to these pipes the question of friction must not be overlooked. In all cases where the water reaches the hydrants by gravity it is of paramount importance that the valves should be of the simplest construction and unlikely to become set fast through neglect. The means of connecting the hose should also be of such a character that a novice, however agitated, cannot become involved in any difficulty.

In the event of a fire everything depends on the promptitude with which the first supply of water is brought to bear upon the outbreak. Every minute is of the greatest value. Wheel valves are liable to become set when not in frequent use, and when this is so some confusion may occur, the operator being uncertain as to which way the wheel should be turned; time is also lost in turning the wheel before the valve can be completely opened.

With a full-way lever cock with a long handle, such as the handy straightway valve shown in the illustration, this is obviated. The hose connexion (Fig. 3) is also much better adapted for private use than the regulation screw pattern. Being a spring connexion it only requires to be pushed into the socket provided in the valve with one hand, whilst with the other the lever of the valve is pulled down. The valves and connexions should be fitted in addition with screw threads of a pattern to fit the hose in use in the local fire brigade. Besides the hose connexion shown, which is largely used, there is another patent of very similar construction, but it has a slight disadvantage, as the coupling cannot be so readily undone by one man and the latch joint is not quite so complete.

In addition to the constant supply to the hydrants which should be fixed both inside and outside the house a supplemental one is sometimes obtained by pumping directly into the hydrant mains, in which case some provision may be necessary to prevent the water from being forced back into the supply tank or by the use of a pressure augmenter.

FIG. 3.



METHODS OF RAISING WATER.

46. The best means of raising water to a storage-tank depend upon so many local conditions and are so varied in their character that they can only be referred to somewhat briefly.

47. *The Ram.*—Where such a supply is derived from a stream a water-ram is at once the simplest and most economical engine to use, provided the height to which the water is to be raised does not exceed some 150 ft. With any height much above this the amount of water wasted in proportion to that raised is excessive. A ram cannot be used with a less fall than 12 in., and one greater than 6 ft. is not desirable owing to the strain and consequent wear of the ram. A ram will not raise water to a greater height than that of twenty-five times the height of the fall given, in practice it is usual to keep well within this limit. The fall necessary to raise a given quantity of water depends upon the volume available in the stream or reservoir, the friction due to the length of delivery pipe, and the height to which the water has to be raised. Rams are made capable of utilising from 50 to 80 per cent. of the available power. The makers will be found always ready to supply the necessary information as to the required fall and size of ram upon being furnished with the requisite particulars. The difficulty is not so much in obtaining the required head of water to work the ram; this is easily got by sinking the chamber in which it is enclosed into the ground at a short distance from the stream from whence the water is conducted in a stout iron pipe; the trouble is rather in disposing of the waste water, which usually has to be returned into the stream at a lower level or may be utilised to work a second ram.

48. *Water Wheels.*—In cases where a ram cannot be used a water-wheel will frequently be found the most suitable means available for obtaining power to raise water up to a building. The power thus obtained has the advantage that it is capable of being utilised to raise water from a source other than the stream working the wheel. For instance, where the water in a stream is unsuited for domestic use water may be conducted from it in a pipe to a distance to work a turbine wheel, from which power can be obtained to work a deep well or other pump, the waste water after working the turbine being carried into the nearest natural outlet.

Another, and in some cases a more convenient, method is to fix the turbine or other wheel directly in the stream, the turbine working a dynamo; the electrical power thus obtained is easily transmitted to any distance.

49. *Windmills* may often be used with advantage, but where this is done the reservoir must of necessity be larger. The power being intermittent it is usual to calculate an average of 30 per cent. as the time the mills will be at work; the more exposed and open the position they occupy, of course, the better will be the result. The sails of these mills are circular in shape and their size is calculated from the horse-power desired and the average velocity of the wind in feet per second.

50. *Pumps.*—Pumping by manual labour is a slow and unsatisfactory process. Horse and steam power are mostly available on a farm.

51. *Portable Steam Engine.*—There is a light and portable engine to be obtained with pump attached mounted on a four-wheeled carriage. It can be used in the event of a fire to increase the pressure of the delivery from the hydrants by connecting to them or to the standard suction pipes as already described, or amongst other purposes it can be used for pumping into a tank from a well by means of the driving wheel and belt with which it is fitted.

52. *Stationary Engines* suitable for pumping are made not only for steam, but for gas, oil, hot air, and electricity.

WATER STORAGE.

53. In the formation of a reservoir several things have to be considered : the probable daily consumption to be provided for, the annual rainfall, and the loss from absorption and evaporation. No advantage is to be derived from the storage of good water in a reservoir unless such water is already impregnated with iron or earthy matter, in which case it will be improved by exposure to the air and cleared by subsidence.

54. *Effect of Sunlight.*—Experiments show, on the one hand, that direct sunlight acts upon water so stored by tending to destroy bacterial life to a depth of five feet, certainly a most desirable result ; but, on the other hand, it also encourages vegetable growths. Such growths, though they may at first improve the water by reducing the nitrates present, afterwards tend to deteriorate it by decay and by promoting insect life.

55. *Effect of Exposure to Air.*—As an instance, water from deep-seated springs and wells which contain but few microbes per c.c. will in a few days after exposure in a reservoir contain many thousands. A great distinction must be drawn, however, between such a water and one impregnated with sewage, though the number of microbes present might be the same in each, those present in the reservoir being in all probability non-pathogenic. In a reservoir the sides should as far as possible be perpendicular, or nearly so, to discourage the growth of vegetation. With this form tho difficulty of rendering them watertight is greater.

56. *Hydrant Reservoir*.—Where a reservoir is essential for a domestic supply it is of course a great saving of expense to use the same for the fire hydrants. The objection to this arrangement, however, is that the pressure requisite for the hydrants is very undesirable for the fittings for the domestic supply, necessitating additional strength in the pipes and brass work and frequently causing much noise and vibration when taps are turned off. As to the quantity necessary to be retained for this last purpose it must depend not only upon the size of the house or farm buildings but also upon the facilities that exist for replenishing the reservoir in the event of an outbreak. Where a reservoir is used for the dual purpose the domestic supply should be taken in a separate pipe connected with the reservoir some distance from the bottom ; by this means a reserve will always remain in case of fire. The probable quantity required in case of fire is generally taken at 300 gallons per minute for two hours, which would require 36,000 gallons, but this must depend upon the extent of the premises. The height at which the reservoir is fixed and its distance from the house will greatly influence the size of the hydrant mains, the friction in mains of varying diameters and lengths greatly affecting jets of water from the same head (see par. 41). This very obvious fact is one frequently lost sight of and is the cause of much disappointment and useless expense. If dependent upon rainfall the reservoir should be able to hold about one-third of the annual supply.

57. A reservoir, in addition to the points already mentioned, will be influenced somewhat as to size and character according to the source from which it is to receive its supply, whether it is dependent upon the rainfall or a deep-seated spring, or if it has to be charged by pumping from a well or stream.

58. *Impounding Reservoir.*—In the case of impounding water in a gully formed by some mountain stream an excellent plan is to build one or more walls across the channel. Care must be taken that the dam be placed upon the rock so that no water can escape under it ; if this cannot be done an embankment will be found preferable. It will be necessary in the case where there is a chain of reservoirs to provide sluices in the upper walls to recharge the lower reservoir when it is exhausted ; the sides also of the channel must be carefully examined and all fissures or other possible means of leakage stopped. The outlet of the supply pipe should be taken from the side in preference to the end of this reservoir, and it is well to make some provision by means of a float or otherwise to discharge all surplus storm water through a by-pass and not over the top of the dam. The same precautions are necessary to protect this basin from pollution by cattle, &c., as were recommended for a spring-head (see par. 19).

Note D.—Full particulars as to proportions of embankments, height, and width of sides, bywash slope, &c., will be found in Rawlinson's Rules for Water-supply, "Spons' Builder's Price Book."

59. *Brick-built Reservoir.*—Where no facilities exist for utilising a natural basin or the rain water has to be collected on a roof or artificial gathering ground a reservoir should be built to receive the water. The bottom of the tank should be above the level of the surrounding ground to avoid risk of pollution, though it may be advisable that the retaining walls should be strengthened by an embankment of earth in order the better to resist the pressure and also to maintain an equitable temperature. It is better to divide the reservoir into two or more compartments connected with each other and with the inlet and outlet pipes by valves; this facilitates the execution of any repairs, particularly in such cases where the domestic supply is drawn off some distance from the bottom of the tank. It admits of any one section being cleaned without interference with the general supply to the house. The tank is covered over with iron joists and concrete after the manner of a fire-proof floor, and is then cemented or asphalted on the top (see Table of Rainfall, par. 185, also Fig. 20).

60. *Evaporation.*—Bearing in mind, as already stated, that the amount of evaporation from an exposed body of water is on an average some 30 in. annually in depth over the whole surface, the deeper the reservoir can be made in proportion to its exposed superficial area the better. Vaporisation also being dependent upon the temperature of the air, its density, deepness, and stillness, it follows that the cooler and less exposed to draughts the air above the water can be kept, the less loss will be sustained on this account; the loss can be reduced to about 6 in.

61. Dr. Dalton gives the following as the result of some experiments of evaporation from water surfaces :—

March	0·33	inches per day.
April	0·55	,, ,,
May	0·75	,, ,,
June	0·63	,, ,,
July	1·22	,, ,,
Hottest weather	2·00	,, ,,

62. *Elevated Tanks.*—In some cases where no suitable natural elevation exists on which to build such a reservoir it will be necessary to erect one or more large iron tanks upon some sufficiently strong building of brick, iron, or wood, always bearing in mind that in addition to the weight of the cistern each gallon of water stored at a temperature of 60° will weigh about 10 lb. There are, again, other instances where the original source of supply is at such an elevation and distance from the house that it may be desirable to bring the water down in steps by means of a chain of smaller reservoirs, so shortening the mains and relieving the pressure. In such cases each main must be under control by means of a valve. In some districts—such as chalk or rock formations—always bearing in view the chances of pollution, an open reservoir may be formed by simply puddling a depression or excavation made in the surface with clay.

63. *Small Properties.*—In small properties the collection and storage of sufficient rain water for domestic purposes presents greater difficulties owing to cost than in larger ones. Certainly underground tanks might be formed, as is the custom in some places, and these, if circular in shape, can be made very sound if lined with cement, which can be done at a small expense, the water being drawn by a pump. Such tanks, however, are liable to great risks and much sediment always collects in them, though if it could be assured that the water would only be used for purposes of washing they would afford a valuable adjunct to a purer supply.

64. *Daily Consumption.*—In towns and manufacturing districts it is very difficult to arrive at a correct average of the consumption of water per head of the population, as it depends so much upon the occupations and surroundings of the people, also upon waste through defective fittings. At an inquiry by one of the Royal Commissions on Water-supply the late Mr. J. Simpson, whose name is so closely associated with water in connexion with the dairy interest, gave a list of fifteen towns in which the average quantity was twenty-one gallons for domestic purposes, whilst Mr. Bateman supplied a list of eight or ten towns in which the domestic supply was twenty-five and a half gallons per head per day, and recent experience has done nothing to modify these opinions.

65. The eight large companies supplying London collectively have a daily average of some thirty-one gallons per head of the population, varying individually from nearly twenty-

seven to forty-eight gallons; but much of this is used for municipal and manufacturing purposes, while the waste is considerable, some companies finding it cheaper to pump the extra water required than to detect and stop the waste. In a private house where due care is exercised to avoid waste from fifteen to twenty gallons per head per day will be found to be a liberal allowance.

DRAINAGE.

66. *Sewage Disposal.*—The disposal of the solid excreta and urine in sewage by means of water carriage is in thickly populated towns a matter of necessity. In the case of isolated houses and small villages the use of water for this purpose may be considered a doubtful expedient.

67. *The Internal Water-closet.*—Where a desire for increased convenience or a spirit of emulation has induced the occupier of a rural dwelling to introduce an internal water-closet, the course usually adopted has been as follows: the open midden in the garden, the sides of which are mostly formed of dry brickwork, is converted into an enclosed cesspool, from which an imperfectly jointed drain, more often than not built of bricks with flat top and bottom, is led up to the house. Here, in some dark and ill-ventilated cupboard, what is looked upon as one of the more fashionable water-closets, usually of the pan variety, is placed, the result often being to bring sickness or death into what may hitherto have been a healthy house.

68. *Cesspools.*—The question what to do with sewage is a problem the solution of which has of late years exercised the minds of many, and this system of carrying it into, and storing it in, a cesspool or chain of cesspools, there to ferment and develop what is capable of being injurious to health, is undoubtedly the worst possible way.

69. *Overflow of Cesspools into Streams.*—The common practice of conducting the overflow from a cesspool into a lake or stream if within easy access is greatly to be condemned.

70. *Open Middens.*—The only other method at all in general use is the open midden. Where this is situated some little distance from the house, and sufficiently removed from the well or other source of water-supply, though objectionable, it is to be preferred to the enclosed, badly constructed,

and badly ventilated cesspool upon sanitary grounds; being exposed to the air, and as a rule merely a hole dug in the ground, evaporation is rapid, and moreover it contains comparatively little moisture. In many parts of Devonshire, and doubtless in other counties also, closets are constructed bridging across some small stream, and such an arrangement is looked upon by the happy possessor as a great achievement. Possibly, so far as this individual is concerned, it is very satisfactory, not so, however, for the people dependent upon the stream for their water-supply lower down.

71. *Internal Cesspools.*—The occupiers of the smaller or medium class of houses, although they may suffer from the foul air from a cesspool when delivered into their house through a defective brick or pipe drain, are better off than their more wealthy neighbours in this respect. In the larger of the old country houses it was a common practice to build the cesspools *inside* the house, and it must be admitted that their construction is often a splendid example of the bricklayer's craft. In re-arranging any sanitary system in an old house search should always be made for cesspools in the neighbourhood of the bottom closet or soil pipe or in the cellar under these. Recently a cesspool was found under the floor of a large West-end mansion containing not less than seven or eight tons of solid soil. The house had been drained into the sewer many years ago and the builder who did the work was contented to only break in the top of the cesspool and cover it over with some dry rubbish.

72. In the large majority of old country houses cesspools are to be found, if not immediately underneath the house, at all events in very close proximity, the air from the cesspool being frequently drawn into the house when the fires are lighted. The distance that air may be drawn by a fire in old houses where the space under the floors and the hollow partitions, pipe casings, and wall panelling are connected together is very remarkable. This fact may frequently be noticed when search is made for the origin of some escape of drain-air, smoke, or gas.

VARIOUS METHODS OF DISPOSAL.

73. It will be better briefly to treat in order the several methods in use for the disposal of that which in the vicinity of the house cannot but be considered a nuisance:

(1) the water-closet system, in connexion with cesspools to be periodically emptied or used for the purpose of irrigation; and (2) the deodorising system, either by the application of earth or chemicals.

74. The first system and certainly one which finds almost universal favour with the householder, being from this point of view the most convenient, is that of water carriage, the various so-called dry systems requiring more or less daily supervision. In either case there is a large quantity of liquid waste to be disposed of, as by eliminating the discharge from the water-closets not much more than three gallons per head per day out of a possible twenty gallons is diverted, the drainage from stables and farm buildings remaining in addition.

75. *Water-carriage.*—The water-carriage system had therefore better be first dealt with and may be thus divided into seven heads, which will serve to illustrate the means at present in vogue:—

(1) Where the whole of the crude sewage is passed on to large tracts of land, which is called broad irrigation.

(2) Where it is passed on to small tracts of land previously provided with subsoil drain and generally termed intermittent or downward filtration.

(3) Where the solid portion is precipitated either mechanically or chemically in tanks and the effluent after being again chemically treated or filtered is either passed out on to the land or is at once discharged into a stream. Of this nature is the so-called "Ferozone process," in use at Acton. The Native Guano Company in their works at Kingston-on-Thames treat the sewage of a population of some 42,000 upon a similar system. This process is installed at Wellington College.

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(4) Where the whole of the sewage is passed through a strainer and the solids so caught are periodically removed and the liquid portion is either discharged on to the land or disposed of by a system of sub-irrigation.

(5) Biological filters alone or where the sewage is first passed through some form of "septic tank" and the effluent is filtered and discharged into a stream or passed on to the land.

(6) It is undesirable to pass sewage from a single private house direct into the *sea*, as for this system to be satisfactory much depends upon the set of the currents. Any

attempt to carry out such a scheme properly is usually attended with great expense.

The foregoing six divisions will broadly include all the several systems in common use, though these consist of a great variety, varying in detail one from the other.

(7) Lastly, there is the old arrangement of cesspools.

76. *The Dry System.*—The second or deodorising system in which the solid excreta from the closets is dealt with apart from the liquid sewage consists mainly of the following:—

(1) Earth closets in various forms.

(2) Dr. Poore's dry catch system.

(3) The direct collection into vessels containing disinfectants.

To take the several systems in detail as applicable to the present subject.

77. (1) *Broad Irrigation* may be dismissed as being altogether unsuited to the requirements of a single house or estate. For this reason, unless the land available is well adapted for the purpose and is, moreover, of considerable extent in proportion to the quantity of sewage to be disposed of, the solid constituents present are apt to choke the pores of the earth, rendering it "sewage sick" and incapable of assisting irrigation (see par. 90). This system may, of course, be greatly helped by a suitable provision of subsoil drains and it is then called intermittent or downward filtration, No. 2.

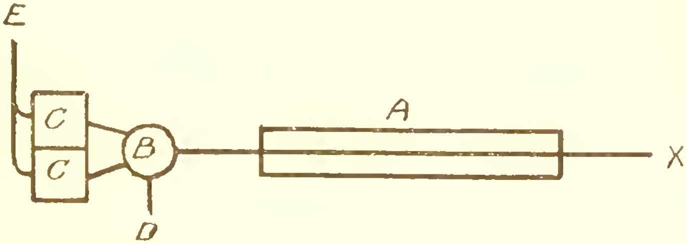
78. (2) *Intermittent Filtration* is, on the other hand, a simple and, on the whole, a satisfactory means of dealing with any considerable volume of sewage from a large estate or public institution. The land necessary to devote to this purpose may be taken in proportion of not less than an acre to every hundred of the inmates—rather more is perhaps desirable. This land is divided into plots, upon each of which in turn the stream of sewage is directed. No single dressing should be of a less quantity than one inch in depth over the whole surface of the plot, so that it becomes necessary to accumulate perhaps a week's sewage for this purpose. The size of the collecting tank and also that of the plot to be dealt with will of course be in due proportion, governed by the number of gallons available, reckoned at twenty gallons per head per day of the inmates. These plots should be six or eight in number in order that sufficient time may elapse between

the dressings. The discharge is usually conducted on to the land through an annular syphon, the action of which is automatic, only the necessary attention being required to divert the stream towards the desired plot (see par. 198). The subsoil drains that collect the effluent are laid at various depths and distances according to the nature of the soil (see pars. 183 and 198). One hundred tons of sewage is required to cover one acre of land one inch in depth, which is the quantity considered necessary for each dressing, or about 22,600 gallons.

79. (3) *Where the Solids in Suspension are Precipitated.* This is effected in two ways, either by allowing the sewage to settle unaided in tanks or the processes are accelerated by the admixture of certain substances, as alumina, that fall to the bottom and entangle and carry down the more solid particles of the sewage at the same time, also to some extent acting as purifiers. The Public Health Act, 1875, requires every local authority (now the district council) to purify sewage before discharging it into a stream (Section 17). The Rivers Pollution Acts of 1876 and 1893 have also done something to prevent the indiscriminate pollution of streams, but on the whole their effect has been disappointing and the machinery provided by the Joint Rivers Boards is more hopeful. The various processes that aim at accomplishing the purification of sewage are far too numerous even to enumerate. The principle in all is invariably the same, the difference consisting in the means used. A short description of one or two systems will suffice to give a good general idea of them all.

80. The diagram (Fig. 4) shows roughly the working of the apparatus, the dimensions of course being approximate.

FIG 4.



The whole construction may be below ground if desired. A is a mixing place, into which the precipitants are thrown; B a Candy patent sewage tank; and C C, polarite filters. The sewage passes into A, where it is treated with ferozone, which contains ferrous iron salts, salts of alumina and magnesia, finely divided porous magnetic oxide of iron and finely powdered polarite, which contains besides the foregoing silica and lime. From A it falls into the circular tank B, where precipitation takes place, and the sludge is raised by the Candy patent automatic apparatus and caused to flow out at the outlet D into a trench, where it is dug into the ground directly or removed and put upon the land. The supernatant liquid, which is fairly clear, overflows the sewage tank B into the filters C C composed of coarse gravel intersected by drain pipes laid upon the filter bottom; above this is 4 in. of fine gravel, then 6 in. of sand, then 10 in. of polarite mixed with sand, and on the top 9 in. of sand. The effluent passes out at E. The above system, though chiefly applied to the sewage of towns with varying success, has also been adapted to the requirements of an ordinary house with but few inmates. There is practically no effluvium provided the small amount of necessary attention is given, the chief point being the disposal of the sludge. In the case of a small property the effluent is dealt with by a system of subsoil drains as described for system No. 4, provided the fall of the ground will allow.

81. The one objection to any treatment of sewage with chemicals is that it produces certain precipitates that delay nitrification and retard its assimilation by vegetation. Sewage so treated is always liable to secondary decomposition. The filters require to be cleansed and their contents renewed at intervals.

82. Another plan is that of the A.B.C. process, so called from the initial letters of the precipitants used—viz., alumina, blood, clay, and carbon. This method has been applied with success at Kingston-on-Thames and Aylesbury on a large scale and has been found equally successful when devoted to the purposes of a country mansion. There can be little doubt upon two or three points connected with this system: first, that the operation can be conducted without serious offence or detriment to health in a populated neighbourhood; secondly, that the guano produced has a definite market value of £3 10*s*. per ton; thirdly, as to the character of the effluent,

in regard to which, before a select committee of the House of Commons upon private Bills, Professor J. Dewar, himself a member of the Royal Commission on the Water-supply of the Metropolis, in effect stated, in answer to questions 923 and 924, that he had examined this process in use at Kingston and was of opinion that such an effluent might safely be admitted into a stream provided the volume of water in the stream was sufficiently large and the water was not immediately intended for drinking. He thought in the case of the effluent at Kingston (which is some 1,200,000 gallons daily) that "it might pass into the Thames with perfect safety." It is, of course, the qualifying question of the possibility of the water ultimately being used for drinking purposes that renders the discharge of such effluents objectionable without having been previously passed on to the land, unless it discharges into a river below any point from which water for drinking is likely to be drawn. The case of a small effluent from a single house discharging, say, from 100 to 500 gallons daily would be different and the effluent might safely be turned into a ditch prepared as described in par. 211, as this amount would soon be absorbed, provided this ditch was at all points removed some fifty or sixty yards from any well or stream.

83. The Kingston Works on the foregoing principle may be thus described. The crude sewage in its passage to the pump well first passes through a screen, which intercepts all matters likely to clog the pumps ; here it is treated with the deodorising and purifying mixtures B.C. It is then raised by means of three centrifugal pumps driven by a powerful engine into a meter chamber and a record taken of its volume. From here it passes into the settling tanks, on its way receiving A., the alumina, which assists the process of clarification by the formation of a flocculent precipitate, the specific gravity of which is slightly heavier than water. The stream is not arrested in its passage through these tanks but passes out into the Thames comparatively clear. These tanks are periodically cleared of the sludge by means of pumps into a well, from which the sludge passes into accumulators by the creation of a vacuum and is then forced by air pressure at 100 lb. to the square inch into filter presses on the first-floor of the building, whence it is removed in hard cakes. These pressed cakes are dried in a drying cylinder, with a fan and condensing apparatus attached, ground into powder, bagged, and sold as native guano at £3 10*s*. per ton. Besides the foregoing arrangements there are two mortar mills for grinding the

chemicals and two vats for dissolving the precipitants. Owing to the necessary outlay upon buildings and plant such a system could only be available for a large institution or mansion or where water power was obtainable.

84. (4) *Sub-irrigation.*—This system is a convenient one for a small house possessing a moderate-sized garden, provided that the ground intended to be sub-irrigated be situated a few feet below the level of the basement of the house to be drained. The system may be adopted omitting the catch pail, but the drain is then more liable to clog and occasionally the syphon tank will require cleansing from the sludge. The house drain after leaving the disconnecting syphon trap falls into a small brick ventilated chamber, access to which is obtained by means of an air-tight iron cover; in this chamber is suspended a galvanised wire pail, which retains the soil and paper from the water-closets. This catch chamber may be situated at any point as most convenient between the disconnecting chamber and another, formed either of brickwork or iron, and capable of holding some 300 gallons of liquid, in which latter is fixed an annular syphon. This syphon when the tank is full discharges its contents into a subsoil drain formed as follows: a close-jointed 4-in. drain pipe is laid from the outgo of the syphon, having on alternate sides junctions 8 ft. apart. This drain may be laid upon dry bricks put crosswise. Into the junctions are inserted branches consisting of ordinary 3-in. agriculture drain-pipes laid some 10 or 12 in. below the surface of the garden patch, also upon a bed of bricks or paving tiles, laid crosswise and flat. Each pipe is bedded upon a dab of mortar, care being taken not to squeeze any into the joints, and a similar dab is placed upon the top of each joint, thus leaving all of them open at the sides. When the syphon discharges, the whole being covered by some 4 in. of rubbish, the liquid oozes out between the sides of the joints of the agricultural drain pipes. These pipes will last for a number of years without attention; should they become choked either by accumulation or by roots it is a very simple matter to take up, clean, and relay the subsoil drain if care is taken not to disturb the bed upon which they rest. The wire pail will require to be emptied and its contents dug into the ground about once a week, not less. The objection to this system is that the drainage enters the soil below the level of greatest bacterial activity and the liquid is chiefly dependent upon the mechanical action of the earth for purification.

85. (5) *Biological Filters.*—Every age is dominated by some impressive discovery and possibly the researches into biology within the last ten years have done more to revolutionise our ideas upon things generally than the knowledge acquired in any similar preceding period of time. No fairy tale told by credulous peasant of the "little people" who labour for the good or punish the wrong-doer ever exceeded in wonder the recent revelations of science. The final and satisfactory disposal of sewage in the presence of a rapidly increasing population is a subject that has an ever-extending influence, not only upon the health, but upon the habits and wealth of a community. However much for purposes which we believe to be advantageous we defer the return of such sewage to the land this must be its ultimate destination. If the land is to be reproductive that which is taken from it must be returned in order to complete the cycle. This theory, though fully admitted in the case of stock and straw, is entirely ignored in the case of human beings and for this the system of water carriage as applied to sewage is chiefly responsible.

86. It is now well known that there exist in nature certain non-pathogenic organisms divided into two classes and named respectively anaerobic and aerobic, whose function in life, under the conditions that their name implies, is to convert the solid portions of animal excreta and effete organic matter ultimately into a gaseous and liquid form by a process of digestion.

87. The following facts, though within the knowledge of readers of THE LANCET, have such a direct bearing upon sewage disposal and water pollution that they must not here be omitted. The ultimate end of all inert organic matter is to be converted into inorganic substances through the agency of bacteria in order to be re-assimilated by other organisms, both animal and vegetable, and if by well-intentioned, though possibly a short-sighted policy, this end may be deferred it cannot be prevented. To secure the most favourable conditions for the development of those organisms whose beneficent action is desired should be the aim of the sanitarian.

88. The process of decomposition is carried out by different classes of bacteria under varying conditions in two distinct ways. Dr. Sims Woodhead, director of the laboratories of the Royal Colleges of Physicians of London and Surgeons of England, gives the following facts: "The first process is the result of the activity of organisms that are capable of

taking up their oxygen from the air, and, second, those the result of the activity of organisms that so break up and re-arrange the organic molecules containing oxygen that not only do they, the bacteria, take up oxygen themselves, but they allow of its being handed on to the products to which in their process of metabolism they give rise. It is probable that here we have to do, not only with nascent oxygen, but that we have certain products set free during the process of decomposition which seize upon oxygen with very great avidity. This decomposition or re-arrangement is spoken of as a process of nitrification or a conversion of the nitrogenous elements into ammonia, nitrous and nitric acids, carbonic acid, and water, or, speaking more generally, it may be said to be a process of mineralisation of the organic forms of nitrogen, phosphorus, carbon, and hydrogen, during which they become finally oxidised or mineralised to nitric acid (HNO_3), phosphoric acid (H_3PO_4), carbonic acid (CO_2), and water (H_2O)." It would appear that the decomposition of organic matter buried in the soil takes place apart from any process of putrefaction, which latter is not only offensive but dangerous to health, and the action is more rapid near the surface of cultivated ground where the soil is porous and readily permeable both to air and water. Here are found the micro-organisms of the aerobic class, whose number is prodigious. As the organic matter is washed down deeper into the soil it is seized upon by the second or anaerobic class of microbes who, unable from their situation to obtain free oxygen, have developed the power of acquiring it from other substances which are broken down by them into simpler forms ; below a certain depth bacteria are absent. The depth is given by Dr. Sims Woodhead as twelve feet, the number present, however, a long way before this depth is reached must be very limited, though this of course varies again with the nature of the soil, its moisture, porosity, temperature, and the amount of organic matter usually present on the surface. Antiseptics or heat (100° C.) at once arrest such chemical change.

89. The formation of nitric acid in organic earth mixtures varies with the amount of oxygen present. According to Miller and Boussingault nitrification is absent in earth thoroughly saturated with moisture and from which the air is excluded, whilst without the presence of oxygen the nitrates in the earth are reduced. Many of these facts, by the way, were pointed out by Dr. G. V. Poore in a lecture at the Sanitary Institute in 1887 entitled "Shortcomings in Modern Sanitary Legislation."

90. *Deductions.*—A knowledge of the conditions favourable to the development of bacterial life throws considerable light upon several points—viz., how polluted water that escapes from a drain or cesspool at a point below that where bacterial life exists will in certain soils that are incapable of mechanical filtration infect water at a considerable distance and depth, whilst the liquid from excremental matter placed upon the surface of the soil would be cleared of its impurities at the depth of a few inches. Such knowledge would assist in the intelligent and proper arrangement of subsoil drains and explain the necessity of the intermittent in place of the continuous discharge of the flow of sewage in all cases of irrigation.

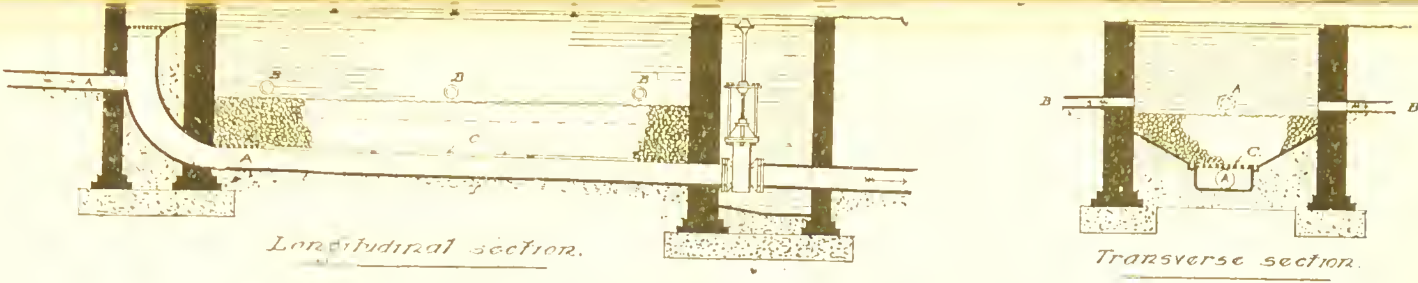
SEWAGE FILTERS.

91. *London County Council Experiments.*—Many of our readers will be familiar with the experiments upon biological filtration of sewage carried out by Mr. W. J. Dibdin on behalf of the London County Council, extending over a period from 1892 to 1895. The results obtained were most remarkable. The quantities dealt with were of course enormous, but the means adopted were of the simplest, one of the most successful consisting of a hole being dug 3 ft. deep in a clay soil, breaking up and burning the clay removed and replacing the same before turning in the sewage. Of the various materials tried burnt ballast or coke breeze was found to be the most effective. The conclusions arrived at were that the action was twofold: (1) all suspended matter was mechanically separated and a clear bright effluent obtained; (2) oxidation of organic matter both in suspension and solution was effected through the agency of living organisms—also, provided that suitable conditions were observed for the preliminary establishment and subsequent cultivation of these organisms, there was practically no limit to the degree of purity capable of attainment; and provided certain periods of rest were allowed to the filters the same might be used for an indefinite time. A full report of the foregoing experiments was published by the London County Council in the County Council Papers, No. 246, price 2*d.*, sold by E. Stanford, Charing-cross.

92. Somewhat prior to these experiments Mr. W. D. Scott Moncrieff was engaged upon a similar course of investigations and in 1891 patented his "Cultivating Tank," longitudinal and transverse sections of which are shown in

Fig. 5. This tank, or rather filter, was filled up to the level of the overflows (lettered B) with flints, upon the surfaces of which the organisms were propagated; an iron grating C supported these cultivating blocks and allowed the sewage entering at A to flow upwards—this channel being named a "restricting chamber." A penstock was provided at the extreme end of this chamber to admit of the occasional escape of any sludge or mineral matter which might from time to time accumulate. The filter is chiefly anaerobic in action, but the effluent is made to pass through a second chamber filled with coke, named by Mr. Scott Moncrieff a "nitrifying channel," in which the action is aerobic. It is evidence of the remarkable reluctance displayed by the community at large to adopt anything like a new departure that so few comparatively of these tanks have come into use. Its extreme simplicity probably militates against it. Speaking from observation of two installations to houses of moderate size nothing can be more simple and free from objections. In the larger house examined the work was carried out under Mr. Philip Webb, R.I.B.A. Two of these filters were fixed side by side and the stream of sewage diverted into each alternately every month, all grease being carefully excluded by means of a grease trap gully. In size each filter measured about 10 ft. long by 2 ft. 6 in. wide and 3 ft. deep. The effluent was clear and almost inodorous. It was passed immediately into a small pond about 30 ft. by 15 ft. in which water newts and pond life generally seemed to be abundant.

By analysis Mr. Scott Moncrieff found that the fall in the quantity of albuminoid ammonia and free ammonia in the effluent was out of all proportion to the amount of dilution when the effluent was made to discharge into a stream of water of three times its own volume, the fall in the albuminoid ammonia being 7 to 1 and free ammonia about 20 to 1. This clearly proved that, beyond the actual liquefaction and purification which had resulted from the passage of the sewage through the tank, an element of instability had been imparted to the organic matter present, rendering it capable of being rapidly oxidised. This led to a further series of experiments, the result of which has been a slight modification in the form of the original filter and the substitution of filter-trays for the original "nitrifying channel." The inventor gives as his reasons for the multiplication of the filter-beds the following:—1. The process of purification by biolysis is a gradual one. 2. By dividing the process into stages each stage will represent a different character of food-supply. 3. No one kind of organism is capable of flourishing in all the different

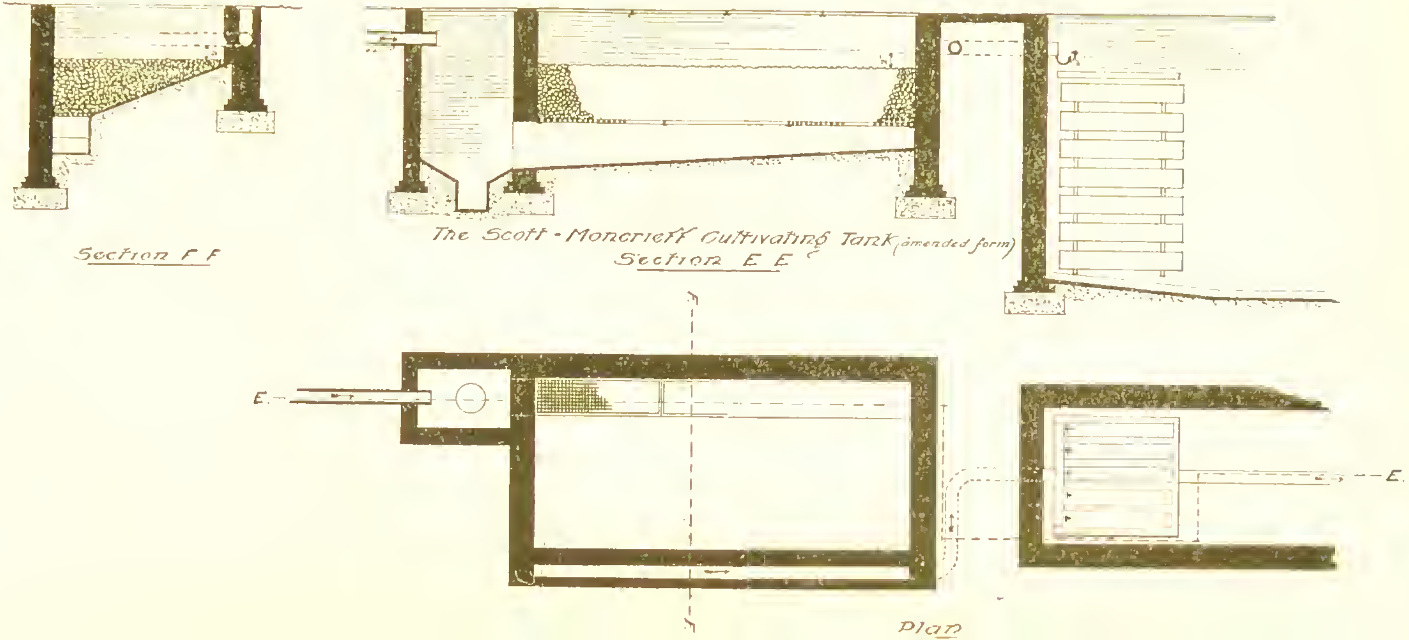


Longitudinal section.

Transverse section.

The Scott-Moncrieff Cultivating Tank. (original form)

FIG. 5A.



Section F F

The Scott-Moncrieff Cultivating Tank (amended form)
Section E E

Plan

media or stages equally well. From this he assumes that each stage should occur regularly if each differentiated group of organisms is to work to the best advantage.

Hitherto there has been little difficulty in the removal of polluting organic matter in suspension which could readily be done by precipitation; the question to be solved was the reduction of the organic matter in solution. Bacteriology has revolutionised all this, and the first object aimed at is to convert the whole of the solid sewage into a condition of solution and by the same process into a state of instability, which renders it eminently susceptible of further change into inorganic elements. This soluble and unstable condition is obtained in the first filter, the first stage being the arresting of the free oxygen present in the sewage by the aid of aerobic organisms and the subsequent liquefaction of the solid organic matter by organisms of the anaerobic class with conversion into ammonia with other changes. Illustration Fig. 5A gives the latest form of this filter and also of the nitrifying chamber containing a number of sieves or trays supported one above the other upon a metal framework. Into the uppermost of these trays the effluent from the first tank is conducted through metal troughs which are balanced so as to tilt over when full and discharge their contents, afterwards automatically regaining their first position. The liquid thus discharged into the top tray percolates into those below, occupying a little less than seven minutes in its progress through the trays. Each tray is filled with coke to a depth of 6 in., the coke being first broken so as to pass through a ring of 1 in. diameter. It will be noticed that there is an air space between each of the trays, so that their condition is rendered thoroughly aerobic.

93. Advocates for the ultimate disposal of sewage on biological lines may be taken as being divided at present into four camps represented by one of the following exponents:—1. Mr. W. D. Scott Moncrieff, the projector of a system of upward filtration under anaerobic conditions, supplemented by a farther downward filtration of the effluent through a series of aerobic filters (see preceding paragraph). 2. Mr. W. J. Dibdin who favours the downward method through filters not altogether dissimilar to the last, but depending almost entirely upon aerobic action. (See par. 91.) 3. Mr. Cameron who dispenses with the filter in the first instance and relies upon a fermentative process, liquefaction being brought about in a large vat, by a floating population of anaerobic microbes, the effluent afterwards passing through a nitrifying or aerobic filter. (See par. 96.) 4. Dr. G. V.

Poore, the last in order but probably the first to recognise the agency of bacterial life as applied to this purpose, may be called the apostle of the dry method. When dealing, however, with slop-water he is at one with Mr. Dibdin. (See his filtration gutter illustrated, Figs. 28, 29, and 30.)

94. The surprising results obtained by these several processes are quickly bringing fresh workers into the same field of research. Amongst others Dr. H. R. Kenwood, Assistant Professor of Public Health in University College, London, and Dr. William Butler conducted a series of experiments upon the practical working of an installation of biological filters at the Finchley Sewage Farm; also with a working model of the same works fitted up at University College, London. During a period of six months from February to July, 1898, no less than 368 analyses were made and the results of these experiments and analyses are embodied in a paper read at the meeting of the Sanitary Institute which paper is probably the most lucid and concise account of the biological treatment of sewage yet published. After due consideration of the several existing methods for the liquefaction of sewage through bacterial agency they constructed three filters as follows. The first, under anaerobic conditions, measured 24 ft. square and was similar in principle to the original Scott Moncrieff tank (see par. 92) only on a larger scale and the action was upwards. The second and third were aerobic in action and the filtration was downwards. The bottoms of these filters were laid with agricultural drain-pipes fitted with valves at the outlets. These pipes were covered with 12 in. of coarse clinkers, supporting 8 in. of anthracite coal dust, on which rested 18 in. of coarse coke. Rows of drain-pipes 2 ft. apart placed vertically penetrated 3 in. below the surface of the coal dust to ensure aerobic conditions in the body of the filter. No. 1 filter remained charged during the whole course of the experiments, but the period during which the sewage was allowed to rest in it was varied from one to twenty-four hours. In this filter the action was upwards. The other filters, in which the action was downwards, were treated intermittently, the overflow from the preceding filter or filters being gently distributed over the surface, four hours' rest being given when full, after which each was allowed two hours in which to slowly empty. By this arrangement each of these filters was charged and emptied twice each day and remained empty during the night.

The following are a few of the principal facts noticed in the report:—Liquefaction of the sludge being naturally a much slower process than the purification of the already liquid portion of the sewage a longer period of rest had to be allowed for this purpose in the first filter, in the construction of which preference was given to one of an anaerobic character having an upward action. An objection to downward filtration was that in time the sludge caked on the top of the filter and required to be raked over. The longer the sewage remained in this filter the greater was the reduction in the opacity of the effluent, but the most rapid filtration attempted did not permit any but the very finest particles of suspended matter to pass through Upon the completion of the experiments very little suspended matter was found in the filter and of this about 43 per cent. only consisted of volatile solids, the rest being grit, hair, and fibres.

In sewage passed straight through this filter the oxygen absorbed by the effluent from permanganate, according to Tidy's method, was reduced about 30 per cent. After the sewage had rested in the filter for one hour the reduction exceeded 40 per cent. An increase, however, occurred in the oxidisable organic matter during the first twenty-four hours on the one hour figure, and afterwards diminished to a mean of about 20 per cent. on that of the one hour. This would indicate a reduction of unstable putrescible matter to an ultimate degree of stability more quickly than that of the more stable organic compounds to the intermediate unstable condition. Afterwards up to twenty-four hours when the amount of the unstable compounds was exhausted reduction to the ultimate stable condition only took place, with an increasing diminution of the oxidisable organic matter. The behaviour of the ammonias quite coincided with the action of the filter on the oxidisable organic matter. One curious effect was noticed—namely, that this filter under certain conditions had the power to abstract and store within itself the ammonia from the sewage. The action of this anaerobic filter was first a straining off of the suspended matter and liquefaction of the same with a partial amount of purification.

The secondary or nitrifying filters.—Of these it was said that changes which could only be expressed in terms of stability and resistance occurred repeatedly which are not indicated by analysis. As a result the importance of a number of these aerobic filters is clearly indicated. For instance, the albuminoid ammonia figure of the effluent of No. 2 filter on a certain day was 0·40. This filter had been charged with an effluent already subjected to twenty-four hours' rest in No. 1, but upon passing into and resting for an hour in No. 3

it was reduced to 0·16, or 60 per cent. Thus neither the long rest in No. 1 nor the hours' rest in No. 2 had satisfactorily reduced the albuminoid ammonia, but the combined action of these two filters had so shaken the stability of the organic matter, as shown by the albuminoid ammonia, that in its passage through No. 3 filter it was reduced 60 per cent. Another argument advanced in favour of a multiplication of these filters is that the effluent first drawn off is relatively much worse than that passing subsequently, also that a filter may suddenly and unaccountably become over-taxed. A filter in its highest stage of biological efficiency will only effect a given percentage reduction on the pollution of its affluent. Supposing the pollution to be high and the filter capable of effecting a purification of 50 per cent. its effluent will still remain a filthy liquid, to be again reduced another 50 per cent. in its passage through another filter. Thus the process is continued till the desired stage of purity is arrived at. As a means of discovering the period of rest required by an over-taxed aerobic or nitrifying filter a daily estimate of the amount of ammonia eliminated per square foot of the surface of the filter was made, it being found that when this process was most active the filter was over-taxed and nitrification was practically at a standstill; and when with rest this elimination of ammonia ceased the filter was again found ready for work. Finally, the reduction of the unstable to the stable or ultimate was best effected by change of filters; that of the stable to the unstable by rest in a filter. High albuminoid ammonia, as already stated, indicated rest; high oxygen absorbed was an index for passing the effluent on to another aerobic filter.

95. *Vidangeuse Automatique.*—Upon biological lines but less exhaustively treated is M. Louis Mouras' "vidangeuse automatique," consisting of an air-tight box through which the sewage is passed and in which the anaerobic microbes are developed.

96. *Septic Tank at Exeter.*—The city of Exeter in 1896 adopted this principle with certain alterations and additions, for which Mr. Donald Cameron, the city surveyor, obtained a patent. A very full report of this tank and apparatus appeared in THE LANCET of Dec. 5th, 1896. Briefly it is as follows:—

About 90,000 gallons of sewage are dealt with daily and the installation is situated near to the town on the banks of the River Exe. With the exception of the septic tank, which is covered by a grass mound, the whole of the works may be said to be below the ordinary level of the ground.

The septic tank is 64 ft. by 18 ft., with a depth of from 7 ft. to 10 ft. and a capacity of from 61,000 to 72,000 gallons. Immediately outside the entrance to this tank is a small chamber, access to which is obtained by means of a manhole. This chamber, divided longitudinally into two compartments, is also provided with a cross weir adjacent to the tank, and into one or other of these compartments the raw sewage is turned, which allows of the one at rest being cleared of any deposit which may have accumulated. In each of these is a coarse screen, intended only to arrest any foreign object which might have gained access to the sewer. The inlets to this chamber, placed close to the bottom, being larger than the outlets into the septic tank, the sewage enters the chamber under a certain amount of pressure, thereby agitating any sediment, such as road drift, and enabling it to separate from the organic matter present; from here it flows gently over the submerged weir which divides this chamber from the septic tank The tank itself is deprived as much as possible of light and air, and in it the sewage remains for some little time almost stationary, eventually escaping from the outlet which is situated about the middle depth. Under these conditions the anaerobic microbes multiply with such astonishing rapidity as soon to dominate the situation and unless for the entrance of fresh matter would be themselves destroyed by their own products.

By descending a manhole placed in the centre of the tank and fitted with a window may be seen a layer of floating scum containing the lighter solids, and at the bottom a thin layer of heavier sediment.

The greater part of the organic matter of the floating substance being dissolved the residue is drawn to the bottom by the ash, but here it is evidently seized upon by the microbes and a bubble of gas is formed which buoys it to the top again; here the gas escapes and it again falls; this process continues so long as any organic matter remains. The whole tank is alive with these particles and gas ascending and descending. The escaping gas being ignited the residue consists of inorganic ash upon which the microbes cannot feed; it was found that 2,000,000 gallons of sewage passing through a tank 24 ft. by 9 ft. only produced 4 in. of this sediment; a perfectly liquid effluent of a brownish-yellow tint most suitable for purposes of irrigation is the result. It is said that the action of the microbes is not interfered with by the presence of a certain amount of chemical waste from factories. At all events this is the case at Yeovil where it has been tried. Upon leaving the septic tank the liquid sewage has a slight odour, but after aeration in overflowing the sides of a V-shaped trough through which it passes on its way to the filters this odour is lost.

In the filters, of which there are five, two in alternate use and one at rest, the nitrifying organisms of the aerobic class are busy at the work of oxidation ; this process is arrived at by the ammonia present being converted into nitric acid which combines with the bases present to form nitrates.

Coke, breeze, and clinkers to a depth of five feet are used in the filters and as each is charged an ingenious invention, forming part of Mr. Cameron's patent, diverts the flow automatically into the next filter and at the same time opens a valve which discharges the contents of the one just filled.

It has been found important that each filter should have a rest of one week in four. From these filters it is possible to obtain a perfectly clear filtrate containing a fifth of organic nitrogen per 100,000 parts, which is less than the amount suggested as being admissible by the Rivers Pollution Committee. Some fixed standard is desirable as to the amount of pollution that should be admitted into streams, these points being as a rule left for the decision of the chemist for the time acting on behalf of the several conservators.

97. *Dr. Poore's System.*—A description of Dr. G. V. Poore's system will be found illustrated in the treatment of the bailiff's house and lodge in the following example. The preference has been given to the water-carriage system when dealing with the mansion and other buildings, but the dry system is equally applicable, less expensive, and has under certain conditions an element of safety difficult of attainment in any system of water-carriage. With the dry catch very little attention is necessary, and the filtration gutter (par. 211) for any house of ordinary size can be used with perfect safety and moreover requires no attention. To quote from Dr. Poore's book, "Rural Hygiene," water fouled by domestic use should be thrown on the nearest available piece of ground ; some will be thus evaporated, some will be absorbed together with much organic matter by the roots of growing plants, and the rest will filter slowly through the earth and find its way to a watercourse in a state of practical purity. In sewers and cesspools there is neither heat nor cold in summer or winter

In their muggy, damp atmosphere evaporation and oxygenation are impossible. And waste water, after travelling miles of pipes, is not appreciably diminished in volume and is charged in addition with whatever impurity it may have met with in its dark journey.

By the kind permission of Dr. Poore a girls' school and several cottages at Andover have been recently inspected where this system has been in use since 1891 and is acting most admirably, the actual results derived from the direct application of the sewage to the soil being very remarkable.

98. *Practical Details.*—Dr. Poore, who has devoted great attention to the deodorising system of sewage disposal, with highly gratifying results, says that the most favourable conditions for the growth of these bacteria are the presence in the earth of 33 per cent. of moisture, with a temperature of 50° C., also that the activity of these organisms is governed by many other conditions and that decomposition is controlled by the predominating factor for the time being. It will therefore be seen that the most suitable earth to use in an earth closet is the top layer from cultivated ground, which is more readily permeable to air and water; taken from a south slope would be best, but of course the nearest approximation to these conditions must be accepted, on no account, however, must the earth be dried by a stove. This should be done in an open shed. The power of the earth to humify excreta is increased by repeated use, as might be expected from what has been stated, owing to the increase of bacterial life, for this reason any large quantity is not absolutely necessary. Provided it be stored as stated in an open shed thoroughly exposed to the air and occasionally turned over, it will, according to Dr. Poore, be ready for re-use in some time varying from three weeks to three months, this being governed by the nature of the weather prevailing.

99. One of the great evils of the ordinary cesspool system is that all the gases generated by the fermenting mass of soil are confined and have no means of escape, or if any provision for ventilation is made it is mostly inadequate. A small grate as a fresh-air inlet, with perhaps a 4-in. outlet pipe, would do no more than relieve any pressure of gases that existed, but the air thus admitted could not oxidise the contents. Where no provision is made for ventilation the drain up to the house is in bad condition and the sewage

gas is absorbed into the water in the traps, which if not frequently recharged will when saturated freely give it off into the air around.

100. In a cesspool with a covered top there are no conditions existing favourable to the oxygenation of its contents or to the development of those forces conducive to aught but putrefaction. The late Dr. Murchison held the opinion that these putrefactive changes in dejecta were themselves a cause of typhoid fever apart from the admixture of any specific poison, but this view would not now receive general support. The difficulty of rendering these cesspools permanently water-tight under the pressure to which they are subjected and the occasional escape of the liquid contents below the surface of the soil, which alone is capable of converting its impurities into purely inorganic compounds, should caution all against their use.

THE DRY SYSTEM.

101. *The Practice of Antiquity.*—In many things we are no wiser than our fathers. To go back to Moses, with what success did he conduct that vast horde of emancipated slaves for forty years under most unfavourable circumstances, and this by a strict adherence to hygienic laws?

102. *Moule's System.*—The Rev. Mr. Moule's dry-earth system, if properly attended to, is an efficient and inexpensive method ; but, as already mentioned, everything depends upon this, for if the closets are neglected the system is about as objectionable a one as can be used. Mr. Moule advises that one or two loads of earth, as may be necessary, should be placed in a dry open shed, divided in the centre, and when dry placed in boxes attached to the closets. By lifting a handle a charge of earth is thrown into the pail each time the closet is used. A box at the side of the closet for earth and a metal scoop is to be preferred to this mechanical arrangement, as the operator is able to throw the earth well over the dejecta. Day by day the pails are emptied into the shed on the opposite side of the division to that which contains the dry earth. By the time the whole of the two loads of earth have been passed through the closets and are piled again in the shed the whole will be sufficiently dry for re-use. The process may be repeated many times, each time improving the manurial value of the earth. Where water is

scarce and proper attention is given, this system is undoubtedly of value. If doors large enough to pass a pail through are fixed in the external walls to give admission to the space under the seats of the closets, the pails can be changed from the outside at stated and convenient times. Provision must be made for the disposal of the waste water from sinks, bath, &c., but it is less difficult to dispose of this entirely liquid matter and the quantity will be somewhat smaller than if water-closets are used. A modified system of irrigation is the only safe and proper way of dealing with the household slop water.

103. In a series of very full and able articles upon "Drainage and Sewage Disposal" that appeared in the latter part of 1896 in a paper devoted to architectural construction, the *Builder*, it is particularly gratifying to find hearty support given to more rational methods than have formerly prevailed. It refers to the altered conditions caused by the increased population having originally led to so-called sanitary reforms and the adoption of the prevailing sewerage systems, which systems would seem more or less an endeavour to relieve nature of the responsibility of dealing with the question. Finding that these methods were no efficient substitute for nature's laws sanitarians are now upon a surer road to success by becoming her humble students. Speaking of the dry system the *Builder* adds: "It has been pointed out that the suspended organic matter in water-carried sewage consists principally of fæcal matter and constitutes the chief difficulty in disposal. The solid excreta may be taken on an average as amounting to four ounces per head per day. Assuming the total amount of the sewage at twenty gallons per head per day the solid excreta only forms $\frac{1}{800}$th part. The main object of the chemical treatment of water-carried sewage is to extract this solid excreta in order that the remainder or liquid portion of the sewage may be properly treated. The excreta, which before dilution possessed considerable manurial value, after separation by precipitation becomes of very little value. The system of water carriage and subsequent chemical treatment from this point of view is analogous to intentionally losing a needle in a haystack and then with much labour recovering it—rusty. Where possible prevention is undeniably better than cure, and if the solid fæcal matter can be excluded from the sewage in the first instance without causing a greater difficulty in another direction such a system must be the best."

104. The nitrifying power of the soil depends, as has been seen, upon the presence of bacteria, and these are dependent again upon the amount of air present. It is possible by thoroughly draining a porous soil to greatly extend the area of microbial life downwards. In intermittent irrigation air is drawn down by the water as it soaks into the ground. With sewage in a liquid form uncharged with chemicals likely to delay nitrification a well-cultivated plot of land of limited area would be quite equal to the requirements of even a large establishment.

THE COUNTRY HOUSE.

105. That the example given in the Report of the insanitary condition of the country house, though an imaginary one, is a fair specimen of many such houses which are to be found throughout the country, the following details extracted from a paper read by Mr. Maurice B. Adams, R.I.B.A., at a general meeting of the Royal Institute of British Architects on Jan. 8th, 1894, will show. The paper relates to the Drainage and Water-Supply of Blickling Hall, Norfolk, which was erected in the year 1620 upon the site of a former building. The house, like many of its class which were constructed about that time, stands in a hollow. The whole of the ground surrounding the house was water-logged and it would appear from the analysis of the water which was procured at the well-sinking operations that this water might be described as diluted sewage. The house was surrounded by a moat, beneath which ran an old and defective brick culvert which received all the drainage. This culvert after delivery into a cesspool passed under one end of the bed of a lake about 500 ft. from the house and was finally lost in a copse three-quarters of a mile away ; here the overflow sewage mingled with the surplus water of the lake, which was 18 acres in extent, and this water formed a small stream extending for some miles. The floor of the older part of the basement of the hall was usually covered by this sewage-polluted water, boards being laid down for the servants to walk upon, and in wet weather they were dependent upon a pump to keep the water at this normal level. Two of the water-closets were situated in the centre of the building and had no external ventilation whatever. None of the closets had any ventilated lobbies ; soil-pipes and drains extended in all directions, while D-traps were used everywhere. An ancient cesspool was found under the middle of the private drawing-room and had probably belonged to a former building, as no cause could be assigned for its existence. When this cesspool was opened it appeared as though it had been but recently used, no doubt owing to the water-logged condition of the ground.

In sinking for the well the pipes were driven through a chalky clay with boulders at intervals. At a depth of about 80 ft. there was obtained in small quantities a milky water charged with recent sewage and ammonia. After going down to 100 ft. the water was found to be if anything worse and the well was abandoned. An analysis of the water taken from the stream (from which a ram pumped the domestic supply to the house) notwithstanding its questionable surroundings gave very good results. It is not stated under what circumstances this last analysis was made, but probably if the sample was taken at any other time than after a heavy downpour of rain this result might be expected. Any moderate quantity of water collected by the stream after filtering through the upper 6 in. layer of the living earth where bacterial life is most active, and above the point of direct pollution from the old culvert and cesspool, would yield a result altogether different from that to be expected from the water taken from a water-logged basin polluted by years of soakage from the sewage of the house, though it may have passed through any quantity of dead earth where the action would be only mechanical; chalk marl would also be a very bad medium for this purpose.

REPORT AND SUGGESTIONS.

(*See Plans No. 1 to No. 12.*)

106. *The Roof.*—The main roof is divided by chimney stacks into three principal bays; the two outer bays are again divided into four equal parts, each part being covered by a hipped slate roof surrounded by lead gutters. On the north-west end of the central bay there is a room formed in a curbed roof, having two dormer windows, whilst a third dormer window gives access to the roof. The whole of the central bay and this room are covered with lead, with the exception, of course, of the skylights over the main and the second staircases and of the lantern light over the centre of the hall.

107. *Rain-water Pipe* **A** is a 4½ in. seamed lead pipe which conducts the water from the west bay into cistern **Q**.

108. *Recommendation.*—This pipe will remain as at present, the top being fitted with a galvanised wire guard.

109. *Rain-water Pipe* **B** is a similar pipe which carries the water from the whole of the north bay and from nearly half of the central bay and delivers it into cistern **Q**.

Note E.—A part of this water first passes through a trough gutter under the floor of the room in the roof (see plan 3); this gutter has sunk in the middle and is half full of mud. The front gutter has evidently been used as a receptacle for bedroom slops; as the water from cistern Q is drawn at the sinks this practice is a very serious evil.

110. *Recommendation.*— This pipe **B** is to be removed and a 4 in. galvanised head fixed, the outlet from which is connected by means of a 4 in. branch into new rain-water pipe **C**, the present communication from north bay cut off, and the brickwork and gutter made good. A new head and pipe **C** similar to last is to be fixed as shown on amended plan, carried down and connected directly with the new rain-water drain (see *Note B*). Cut a fresh outlet on the S.E. side of cistern-room into north bay and reverse the fall of existing gutter between it and the old trough gutter; which last is to be removed and any work disturbed made good, including the connexion between gutters through parapet wall.

Note F.—The use of a gully where there is a separate drain for rain-water is a disadvantage, as it forms a receptacle for dead leaves and dirt An eye must be provided at the foot of each pipe to allow for clearing same. These inspection eyes are made in the form of a square cast-iron box with the necessary sockets and cap.

111. *Rain-water Pipe* **D** receives the water from the larger portion of the central bay and is a 5 in. seamed lead pipe carried down in an unused flue. It acts as a soil and ventilating pipe to water-closet **T** and is connected with a cesspool in the cellar. This pipe having been fixed with insufficient lead tacks has torn in two places, the worst fracture being just below the junction of the arm from the water-closet. The waste water from sink **JJ** and from the bath also discharges into this pipe.

Note G.—Owing to the pipe being in a flue which is open at the top a considerable time might pass before the defect would be discovered, the leaking water running down inside the flue and soaking into the cesspool round the course of the drain. The practice of using empty flues as drain ventilators and as receptacles for soil-pipes is, of course, a highly dangerous one.

112. *Recommendations.*—This pipe must be done away with entirely and the flue below the fracture must be exposed on one side and thoroughly cleansed, dried, and lime-washed before being made good. Air-bricks should be inserted at the foot to admit a current of air to pass through it. The rain-water can be carried from the flat in a 3½ in. strong galvanised cast-iron pipe with caulked lead joint in the same course as before as far as ceiling of cellar, it is then to be carried along ceiling under hall and breakfast-room and connected into new rain-water drain as shown on plan No. 11. Moveable casings should be fixed to flue where this pipe passes through the corridors for access to same.

113. *Rain-water Pipes* **E** *and* **F** are 4½ in. seamed lead pipes which take the water from the south and east bays respectively; they are connected directly with the brick drains in the cellar.

114. *Recommendation.*—Connect these pipes with new rain-water drain.

115. *Rain-water Pipe* **G**. The roof over the wing is some 16 ft lower than the main roof. At the south-west end there is a shallow lead-lined tank **Q** (see plan No. 7), measuring about 30 ft. by 20 ft. by 9 in. deep, which is capable of holding some 2000 gallons. There are draw-off pipes from this tank to the several sinks on ground floor with a standing waste-pipe and overflow-pipe, both of which are connected with rain-water pipe **G**, which last is immediately connected with the drain.

Note H.—Owing to this tank being very shallow it is covered with a vegetable growth. Also on account of the extensive and uncovered surface in warm or windy weather evaporation must be very rapid. The decomposed remains of several young birds could be seen, evidently having been washed down from nests in the rain-water heads.

116. *Recommendations.*—The tank is to be removed and a properly formed 7 lb. lead flat is to be substituted; also the present rain-water pipe is to be altered and connected directly with new rain-water drain.

The water from the two valley gutters is now carried into the tank through a trough gutter under the roof; this trough gutter is very dirty.

The trough gutter is to be removed. The two valley gutters are to be taken up and re-formed at a lower level to deliver into new galvanised cast-iron 3½ in. rain-water pipes (**H** and **I**) with heads, and are carried down and deliver into new rain-water drain. All slating and lead or other flashing is to be made good.

117. *Rain-water Pipe* **J**.—The roof over the kitchen and scullery is composed of slate with lead gutters. The rain-water pipe J is also a soil-pipe from water-closet **X** and is a 4 in. seamed lead pipe carried down into the drain inside in the angle by the sink, with a branch from back gutter over kitchen. This pipe drops into a brick pit forming a trap.

118. *Recommendation.*—Rain-water pipe **J**, to which are now added pipes **K** and **L**. Cut out **J** and provide a new 3½ in. drawn lead soil and ventilating pipe, 10 lb. to the foot run, to be carried up on face of external wall of new side-entrance passage, to receive branch from water-closet **X**. Firmly fix this pipe to wall with 7 lb. cast lead tacks. Three pairs of tacks to be used to each length of pipe. This pipe is to be carried up to a distance of 3 ft. above parapet wall, clear of all chimneys and secured by means of an iron collar and tie; the top is to be fitted with a copper-wire guard. Connect this pipe to new drain with a brass thimble and protect the lowest length to a height of 7 ft. with a stout wood or iron casing.

119 *Rain-water Pipe* **K**.—Provide and fix new 4 in. galvanised cast-iron angle-head, with 4 in. galvanised cast-iron down-pipe, connected with new rain-water drain.

120. *Rain-water Pipe* **L**.—Supply a new 4 in. head and pipe to correspond with last, connected into rain-water drain to take water from E. corner of roof after alterations.

121. Rain-water pipes **M** and **N**. These are short pipes which take the water from outbuildings and deliver into two butts, underneath which are gutters connected into the existing drainage system.

122. *Recommendation.*—Clear away old butts, stands, pipes, &c., and provide and fix two new 3 in. galvanised cast-iron pipes properly connected into new rain-water drain.

123. *Cistern* **O**, which is lead-lined, is in the roof and access to it is obtained through a dormer; this cistern has no lid and is in consequence very dirty. The trumpet-mouthed standing waste pipe is connected into the side of the D-trap of water-closet **S**. The cistern holds about 200 gallons and supplies sinks **JJ** and **KK**, water-closets **S** and **T** and bath.

124. *Recommendations.*—This cistern will be dispensed with and a galvanised iron cistern to hold 400 gallons (**O**) will be fixed in the room in the roof, which will be used as a cistern room (plan No. 3). A 2 in. lead overflow-pipe is to be carried through the wall to deliver into the front gutter. The cistern is to be provided with a wood cover and will be used for the supply of hot and cold water to the three baths and the several sinks. Drill for and connect at the side of the cistern 6 in. above the bottom of the same two 1¼ in. strong galvanised iron pipes with a 1¼ in. screw-down gun-metal stopcock fixed in each close to the cistern, and continue one down to the level of the first floor and follow on with a 1 in. pipe to supply the ground floor. Connect ¾ in. branches from this down service-pipe to supply sinks; the other pipe is carried to supply the visitors' and family baths on second and first floors, also housemaid's sink **JJ**. There is to be a copper float-valve fixed in this cistern in connexion with a branch from the rising main to cistern **P**, which will be so regulated as to open the valve when the water falls below the level of 4 in. This is done as a protection against the occurrence of an accident in connexion with the kitchen boiler in the event of neglect on the part of the person responsible to start the ram to charge cistern **O**. By having the supply to the sinks taken from a level 6 in. above that of the one to the boiler attention will be drawn to the omission owing to the absence of water at the several sinks. Should this fail the float will a little later provide the necessary supply for the boiler but not for the sinks. With a supply of more than doubtful purity a filter would have to be introduced through which this supplemental supply would pass. A separate 1 in. strong galvanised iron pipe is to be carried from the bottom of the cistern into the hot-water cylinder (see par. 165).

125. *Cistern* **P** is lead-lined and holds about 150 gallons; access to it is gained through a trap in the floor of the bed-room above. It is supplied by a separate branch from the rising main to **O**. There is a 1 in. standing waste-pipe in

the cistern which connects into the trap of water-closet **V**. The cistern supplies water-closets **V**, **W**, and the hot-water system through a small supply cistern in the housemaid's closet, the overflow from which last is also connected with the trap of water-closet **V**. The housemaid's sink **KK** is also supplied from this source.

Note I.—The position of the cistern under the floor of the bedroom is objectionable and also the connexion of the waste with the trap of the water-closet. The cistern supplying a valve or pan-closet should not also supply a sink.

126. *Recommendations.*—Remove the cistern and make good the work disturbed. Provide and fix a second galvanised iron cistern **P** in the room in the roof (plan No. 3) to be used exclusively to supply the closets. Provide an overflow-pipe as described for cistern **O** and provide and fix a $1\frac{1}{4}$ in. stout lead supply-pipe carried down to the level of the first floor and fitted immediately at the side of the cistern with a $1\frac{1}{4}$ in. screw-down gun-metal stopcock. Continue on 1 in. branch pipes for water-closets **S**, **T**, **U**, and **V** with a $\frac{3}{4}$ in. branch to water-closets **W** and **X**.

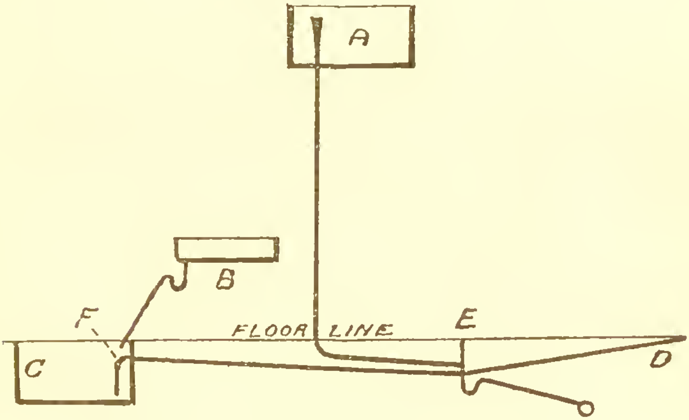
127. *Cistern* **Q** is large and shallow (see par. 115), is formed on the flat, and is capable of holding about 2000 gallons. It collects the rain-water from an area of some 5800 ft.—viz., nearly half of the main roof and the whole of the wing excepting the kitchen This cistern overflows into rain-water pipe **G**, which is a very necessary provision, as the capacity of the tank when its contents are on a level with the overflow-pipe is but a little more than is represented by $\frac{1}{8}$ in. of rainfall. It is therefore evident that in wet weather a very large quantity must run to waste. This cistern supplies a tap at each of the ground floor sinks and a very bad supply to closet **XX**.

128. *Recommendation.*—(See par. 116).

129. *Cistern* **R** which is large and lead-lined, is carried upon wood framing in the scullery and holds about 300 gallons (see plan No. 5) It supplies the ground floor sink and a supply cistern to the low-pressure boiler in the servants' hall, the overflow-pipe from which last is carried through the floor of the room and any waste water soaks into the ground in the cellar. The treatment of the overflow from the large cistern illustrates a well-intentioned if abortive attempt on the part of some local sanitary luminary to bestow upon the mansion some of the blessings of advanced sanitation. The

overflow is carried off by a 3 in. seamed lead pipe and no doubt this cistern was originally supplied by rain-water. This overflow-pipe is immediately connected with the brick drain from the scullery sink. The following diagram (Fig. 6) will more clearly describe the improvement :—

FIG. 6.



A, Cistern with overflow-pipe into new pipe drain. B, Scullery sink. C, Brick-built fat trap (see Fig. 25 in the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work). D, Untrapped drain from the floor of the larder. E, External gully by the side door.

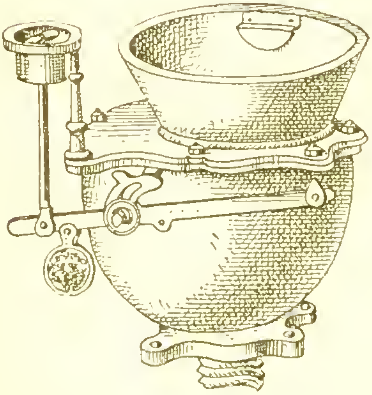
The drain and bend from the fat trap having become blocked a hole had been cut at **F** to clear the same. A smell resulted at **D** and **E** and these gratings were then stopped off with tiles, leaving **A** to act as an unsuspected ventilator to the fat trap, dirty drain, and gully **E**.

130. *Recommendations.*—This cistern will be removed. A Lawrence steriliser capable of dealing with 100 gallons of water per hour will be fixed with all the necessary brickwork flues, &c., at **Z** in the kitchen. Access to the small furnace of the steriliser will be had by means of some brick steps and a platform, a ¾ in. lead service-pipe from rising main to cistern **O** will be carried down to charge the steriliser and the end will be fitted with a ¾ in. screw-down gun-metal bibcock. A 1 in. stout block-tin or galvanised iron pipe is to be carried down from the outlet of the steriliser and connected with a ram fixed on the level of the kitchen floor. If preferred the steriliser and ram may be fixed in a small pump-house adjoining, and accessible to, the kitchen. The waste water from the ram, can be carried into a gully. Carry up from the ram a 1¼ in. stout service-pipe of block-tin or galvanised iron and make the same to deliver over cistern O, bring down in the same course a ½ in. warning-pipe to terminate at the scullery sink or other suitable point. This pipe may be fitted with a hydraulic bell.

Note J.—It is better to use a double ram worked off the main instead of using the sterilised water for this purpose with an ordinary ram.

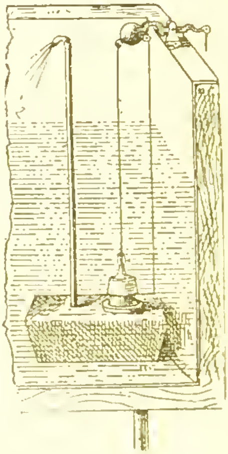
131. *Water closets*.—Closet S is unprovided with a window, although it is situated against an outer wall; it receives a borrowed light from a fixed sash in the partition of the adjoining bedroom. It is intended to be ventilated by means of a square hole in the ceiling fitted with perforated zinc, which if it were not blocked with dirt would allow the air of the closet to pass on to cistern O. It is a pan-closet (Fig. 7) (see par. 22 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work) and is supplied through a service-box in cistern O (see Fig. 8). There is the usual lead tray under the closet with an overflow-pipe into the D-trap (see Fig. 9) which is fitted under the closet.

FIG. 7.



Pan-closet.

FIG. 8.



Cistern and service-box.

132. *Recommendations.*—Form a window in the external wall 5 ft. by 3 ft. with double-hung sash, &c, complete. Make good the hole into the roof. Cut away for and lower the floor of this water-closet, as shown on section and plan (Fig. 12). Access to this closet will now be had by descending five steps. This will allow headway for a false ceiling to be formed over the closet and about 3 ft. below the present ceiling (see Fig. 12). A second window is to be made in the external wall between these ceilings and the sash hung on centres for ventilation; alter doorway and partitions to enclose closet and form new lobby. Prepare the floor and the walls for and line with white tile throughout. Provide and fix a pedestal wash-down closet with a flushing rim and an earthenware slop top fitted with a mahogany hinged seat and lid. Fix a drawn 8 lb. lead **P** or anti-**D**-trap (Fig. 10) under the same and carry a short branch of 10 lb. 3½ in. drawn-lead soil-pipe from the trap of the closet through the external wall to connect to soil-pipe **G G** with a 2 in. anti-syphonage pipe carried from out-go of trap into anti-syphonage pipe from closet **W.** Provide and fix on iron brackets in the closet some 4 ft. or 5 ft. above the basin a three gallon, silent, water-waste-preventing syphon cistern to supply this closet. Connect this cistern to the down service-pipe from cistern **P** by a short ¾ in. stout lead branch pipe fitted with a ¾ in. screw-down gun-metal stopcock and a ½ in. ball-valve to the cistern. Provide a ¾ in. lead overflow-pipe with brass connexion to the cisterns and carry it through the external wall. Lay on water to the basin of the closet by a 1½ in.

FIG. 9.[1]

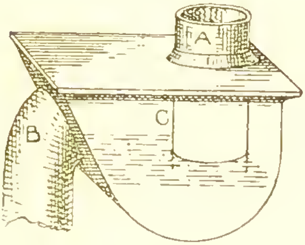
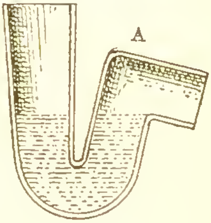


FIG. 10.



Anti-D-trap.

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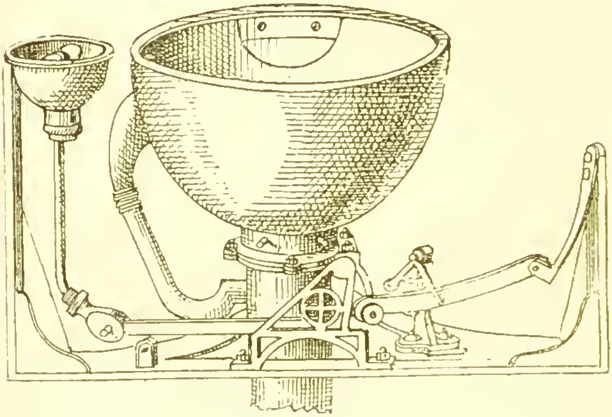
[1] For description see par. 23 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work.

lead service-pipe properly fixed with cast-lead tacks (see pars 24 and 30 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work).

133. *Closet* **T** is of the old Bramah pattern (Fig. 11) with a fan spreader (see par. 27 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work). Like water-closet **S** it has no direct communication with the outer air, having only a borrowed light from the bathroom (see plan No. 6). It is supplied from cistern **O** through a service box and owing to the length and smallness of the (¾ in.) pipe from the cistern the handle has to be held up a considerable time before the water reaches the pan. There is a lead safe under the water-closet which is connected with the soil-pipe of the closet; the waste of this safe is trapped in itself and is kept charged by means of a weeping pipe from the down service-pipe to the arm of the closet basin. There is a D-trap under the closet (see par. 25 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work).

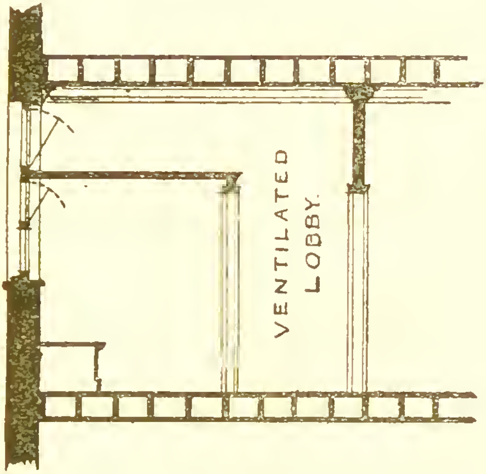
FIG. 11.



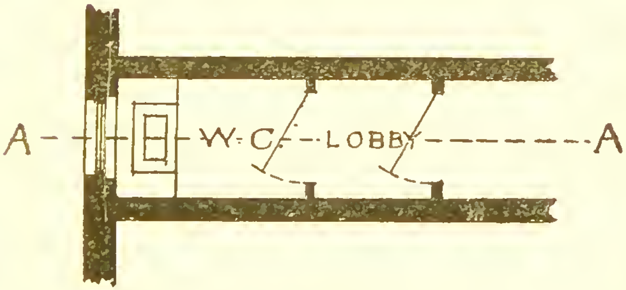
134. *Recommendations.*—Remove this closet, clear away all connexions and make good the floor and ceiling. Erect a stud, lath and plaster, partition across present family bed-room, as shown on amended plan No. 9, with a 2 in

mahogany framed and glazed partition to enclose window, and form new enclosure to divide water-closet from bathroom, after the removal of old partition. Cut new doorway to connect bathroom with bedroom on east side, and provide all necessary doors, linings, skirtings, &c., to form a complete suite of rooms. The lobby to the closet is ventilated as in closets **S** and **U**, Fig. 12. Supply and fix in new closet a valve closet of best make. Fix anti-D-trap under same with soil-pipe **FF**, anti-syphonage pipe, and supply, &c., as described for closet **U**.

FIG. 12.



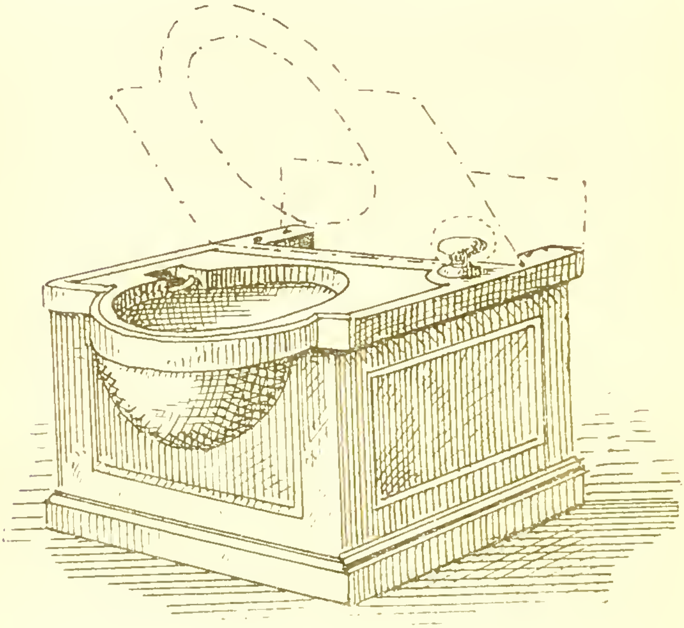
SECTION A.A.



PLAN.

☞ 135. *Recommendations.*—Closet **U** (new). Form a stout stud lath and plaster partition across the end of the north-east bedroom, as shown on amended plan, with a new window of similar height to those adjoining and 3 ft. wide, fitted with double hung sashes. The lobby is ventilated by a window between the present ceiling and the false ceiling enclosing water-closet as in closet **S** Render the walls of the partition on each side down to the floor level and prepare for and tile the floor and the walls throughout. Provide and fix a pedestal valve closet of the best make (see Fig. 13) and

FIG. 13.



lay on a 1 in. branch service-pipe to the arm of the basin from the new $1\frac{1}{4}$ in. down service-pipe from cistern **P** fitted with a $1\frac{1}{4}$ in. screw-down gun-metal stopcock under the seat. Fix an 8 lb. lead anti-D-trap under, as in closet **S**, and carry a stout $3\frac{1}{2}$ in. 10 lb. drawn-lead soil-pipe through the external wall connected to soil-pipe **HH**, fix a 2 in. anti-syphonage pipe from out-go of trap connected into soil-pipe 3 ft. above level of floor, and provide and hang a French polished mahogany seat and lid.

136 *Closet* **V** is similar in all respects to closet **S**, but is provided with ample ventilation and light, having a good window. Owing, however, to the defective condition of the plastering, and to the openings between the floor boards, skirtings, &c., whenever this closet is used a smell is drawn into the adjoining bedroom, as is proved by the fact that smoke can be passed from this closet freely into the bedroom.

137. *Recommendations.*—They are in all respects the same as for water-closet **T**, excepting the treatment of the anti-syphonage pipe which is the same as closet **U**.

138 *Closet* **W** is somewhat badly placed (see plan No. 5), opening as it does directly into the billiard-room. The closet is of the kind known as a side wash-out, with pan and trap in one piece of earthenware (see par. 29, note *L*, of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work). It is connected with a 6 in. drain-pipe continued down to the cellars and carried into the cesspool at the foot of the rain-water pipe **D**.

139. *Recommendations.* — The position of this closet would be much improved if it were arranged as shown on the amended plan No. 8, by which means a ventilated lobby is placed between it and the cloak-room. The doorway on the water-closet side of the billiard-room must be filled in with wood studs and lathed and plastered, and the floor and the walls of the closet and the lobby must be prepared and tiled throughout. Notice that the cloak-room in this case has to depend upon a borrowed light, being enclosed upon two sides with a glass partition. The closet is to be replaced by a good pedestal wash-down closet, with an 8 lb. lead syphon trap. Carry a stout length of 4 in. 10 lb. lead soil-pipe from the trap through the external wall at the ground level, with brass thimble (see Fig. 14, also par. 36 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work) on end to connect into short iron drain to man-hole. Carry up the usual anti-syphonage pipe described

FIG. 14.

Thimble.

in par. 150, provide a flushing cistern, lay on water to the same with a stout branch of $\frac{3}{4}$ in. lead pipe from the down-service pipe from cistern **P**, provide a stopcock, &c., make seat and lid, and in all details finish as described for water-closet **T**.

140. *Closet* **X** is a pan closet supplied with water from cistern **Q** through a valve under the seat. The D-trap below is connected with the rain-water pipe **J** by a stout branch of 4 in. lead pipe It is not provided with a lead safe, which in this case is unnecessary. There is a good window for light and ventilation, but owing to the outlet of the gutter of the roof over the kitchen being just underneath the sill there is the risk of bad air entering from the foul soil-pipe **J**. At times this closet is useless, owing to its defective water-supply.

141. *Recommendations.*— Replace the closet by one with a short hopper basin having a flushing rim. The basin is fitted into a lead cone and fitted into an 8 lb. lead P-trap. Fix an earthenware slop top and a mahogany French polished seat and lid, both to be hinged. Continue a short length of 3½ in. 10lb. drawn-lead soil-pipe through the external wall. This is to be connected into soil-pipe **J** (par. 117) with an anti-syphonage-pipe as described for closet **U**. Provide and fix on brackets a cistern fitted as described for closet **S**. Prepare for and lay tile floor. It is not so necessary to line these walls with tiles if they are properly plastered down to the floor, the walls being of 14 in. brickwork. Make good the skirting round the back of the closet and the linings after the alteration to the window. Cut away and form a skylight in passage where shown by dotted lines.

Note K.—Care is required in selecting these closets as some of this shape are liable when flushed to form a vortex in the trap which is then cleared with difficulty.

142. *Closet* **Y**. *Recommendations.*—Increase size of present doorway and form brick arch. Set back external door and frame to form lobby as shown on amended plan No. 8. The dark cupboard under the servants' staircase is to be studded round at the back and one side is to be lathed and plastered, and the cupboard, floor and walls are to be prepared and tiled throughout. A window about 2 ft. 9 in. by 4 ft. is first to be cut in the external wall and fitted with double hung sashes glazed with obscured glass. There being insufficient headway under these stairs above the water-closet in which to fix a flushing cistern, a good valve

closet (see Fig. 15, also par. 26 of the previous report of The Lancet Special Commission on the Relative Efficiency and Cost of Plumbers' Work) is to be provided and fixed facing the new window. A 1 in. branch pipe is to be connected with the service-pipe to water-closet **W** and is to be fitted with a screw-down wheel stopcock under the seat of the water-closet. Provide a French polished mahogany hinged seat and a lid with a moveable riser or front. Provide and fix an 8 lb. lead syphon trap (Fig. 16) under the water-closet, this being connected with the heavy cast-iron 5 in. soil-pipe by a brass thimble (see par. 36 of the previous report of The Lancet Special Commission on the Relative Efficiency and Cost of Plumbers' Work) and carried through the external wall into the manhole. Should it be possible to connect a 2 in. anti-syphonage pipe into that from water-closet **W** a 4 in. iron drain will suffice. Fix a short piece of 2½ in. thick York stone to support the brickwork where the pipe passes through the external wall.

Fig. 15.

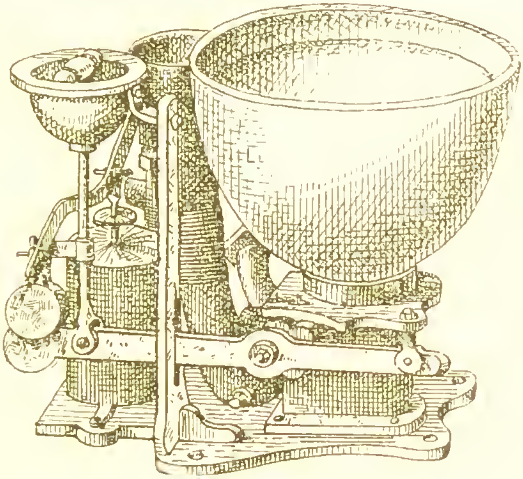
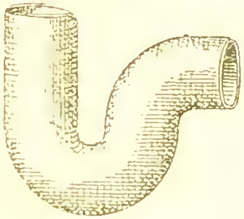


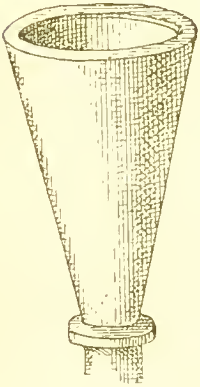
Fig. 16.



Syphon trap.

143. *Closets* **AA**, **BB** (see plan No. 5) are intended for the servants' use, **AA** being for women and **BB** for men. They are fitted with hopper pans and fan flushes (Fig. 17, see par. 31 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work) and are supplied from cistern **R** by means of cottage valves fixed under the seat. They discharge by a short drain-pipe into cesspool. The foregoing on reference to plan No. 5 will be seen to be an objectionable not to say indecent arrangement, in frosty weather, when no water is available, the state of these closets must be very bad. By the alteration shown on the amended plan these closets are still retained as earth closets for the use of the men servants; **EE** is added at kitchen entrance for women and **CC** and **DD** are provided for the use of the male occupants of the mansion and are screened from the gardens by shrubs.

FIG 17.



144. *Recommendations.*—The old closets are to be removed, together with all the old drains in connexion with them, also any wet earth, which last is to be replaced with good dry brick rubbish or available dry earth, and covered with 4 in. of cement concrete after the alterations shown on the plan (No. 8) have been carried out. Cement the wall and floor, this last finished with a slight fall to back of closet, and line with tiles. These closets are raised upon two brick steps, and are not provided with any form of apparatus other than a box at the side to hold dry earth, together with a small shovel with which to throw it over the dejecta, and it is well to keep a hearth-brush in the closet for the removal of any earth that falls upon the seat. The floor of the catch under the seat being cemented one or two shovelfuls of earth are sprinkled over the same after each removal of the soil. This absorbs the urine. Every day or every week the accumulation is removed through a large trap-door at the back of the closet. This door has a space of some 3 in. at the bottom to allow of a free circulation of air. These closets, if regularly attended to, are entirely free from any objectionable

smell and the humus derived from them will be found to be unequalled as a manure for the garden (see Plan 8, also par. 209).

145. *Closet* **EE.** *Recommendations.* — Provide and fix a pedestal closet with a bottom outlet (see Fig. 6 in the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work) and an 8 lb. lead syphon trap. Supply and fix on brackets a 3-gallon silent water-waste-preventing cistern connected with the closet by a 1½ in. service pipe. Lay on water to this cistern by a ¾ in. branch pipe from the service-pipe to water-closet and put a ½ in. ball valve in the cistern. This service-pipe is to be fitted with a ¾ in. screw-down stop-cock close to the flushing cistern. Carry a ¾ in. lead overflow-pipe through the external wall. Connect the outgoing pipe of the trap to a stout iron drain-pipe, all to be as described for water-closet **O**. The floor and the walls are to be prepared and lined with tiles throughout.

146. *Soil-pipe* **D** has already been described (see par. 111). It receives the contents of closet **T** and sink **JJ**, and the waste water from bath.

147. *Recommendation.*—This pipe will be removed entirely and a new 3½ in. 10 lb. lead soil-pipe **FF** is to be provided and fixed to connect with closet **T** with six 7 lb. cast-lead tacks to each 10 ft. length of pipe, the tacks being placed in pairs at equal distances apart. The bottom of the soil-pipe is to be connected by a brass thimble with the iron drain to the manhole. The branch soil-pipe from closet **T** is to be connected, the pipe is to be carried up and finish about 3 ft. above the curb roof and is to be properly secured by an iron stay. A copper-wire guard is to be fixed on the pipe with a 2 in. anti-syphonage pipe from outgo of trap connected to soil-pipe 3 ft. above floor level.

148. *Soil-pipe* **GG** is a 4½ in. seamed lead pipe which is carried down internally and receives the discharge from closets **S** and **V** as well as the waste water from the housemaid's sink **KK**. It is unventilated. and the longitudinal branch connexion with water-closet **V** is much corroded and perforated (see note *N* in the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work). It dips into a small brick pit at the foot, and is connected with a cesspool by a brick drain passing under the lobby of the dining-room.

149. *Recommendation.*—Provide and fix a new 3½ in. drawn-lead soil pipe **GG** connected to water-closets **S** and **V**, finished in all respects as described for the last closet, excepting only the anti-syphonage pipe, which is as follows:—

150. *Anti-syphonage Pipe.*—A strong 2 in. lead anti-syphonage pipe (see note *O*, par. 37 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work) is to be fixed at the side of this soil-pipe with cast-lead tacks weighing 4 lb. each, one pair of tacks being used for every 3 ft. 6 in. of the pipe. The bottom of this pipe is to be connected with the outgoing pipe of the trap of water-closet **W** with branches to the traps of closets **S** and **V**. The upper end of this pipe is to finish about 3 ft. above the curb roof and is to be secured by an iron stay. A copper-wire guard is to be fixed on the top of the pipe.

151. *Soil-pipe* **HH** is new. It is similar to the last and is connected with the branch from water-closet **U**. It finishes some 3 ft. above the coping. The anti-syphonage pipe is carried from the trap of closet **U** and is connected into the side of the soil-pipe 3 ft. above the branch connexion of the closet.

152. *Soil-pipe* **J**.—This has been described in par. 117.

153. *Recommendation.*— A new soil-pipe (described in par. 118).

154. *Soil-pipe* **II** from water-closet **W** is a short 4½ in. lead seamed pipe which passes through the external wall and is connected with the drain communicating with cesspool. There is a settlement where this pipe passes through the wall which has compressed the pipe. The pipe has also been eaten through by rats, thus forming a means of communication between the old brick drain and the interior of water-closet.

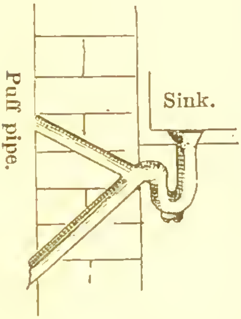
155. *Recommendation.*—This will be replaced by an iron pipe as described for water-closet **W**.

156. *Sink* **J J** (plan No. 7), which is small and lined with lead, is fixed in a cupboard on the landing and is supplied from cistern **O**. The waste-pipe is connected with soil-pipe **D**, already referred to in par. 111 (see also par. 35 of the previous report of THE LANCET Special Commission on the

Relative Efficiency and Cost of Plumbers' Work). There is a small D-trap under the sink, but the waste-pipe is unventilated.

157. *Recommendations.*—A doorway into the adjoining box-room is to be formed after the removal of the present enclosure to the sink and a moulded four-panel door and frame are to be provided and hung. A quarter framed partition is to be fixed to divide the box-room and to enclose one window, to convert same into a second bathroom and a housemaid's closet; the existing doorway is to be shifted as shown on amended plan No. 10; lath and plaster the partition on both sides down to the floor, and provide and fix skirting round the same to match existing ditto. There is also to be provided and fixed upon proper bearers under the window a white glazed earthenware sink 2 ft. 6 in. by 1 ft. 6 in. and a 1½ in. strong lead waste-pipe from the same is to be carried through the external wall, with a lead syphon trap fitted with brass cleansing screw fixed under the sink. A 1½ in. short anti-syphonage pipe is to be connected to the outgoing pipe of the trap, terminating just outside the external wall, and a cross-wire guard is to be fixed over the end of the same (Fig. 18). A 2½ in. galvanised cast-iron pipe UU is to be supplied and fixed externally, the upper end standing some 2 ft. above the parapet wall and the lower end being fitted with a shoe to half channel laid to gully. A junction in this pipe is to be fixed to receive and connect the waste-pipe of this sink and bath waste-pipe. A wire guard is to be fixed on the top of the pipe. All the joints are to be made with yarn and it is necessary to red lead the ends, and the sockets of each pipe are to be painted before fixing. A ¾ in. stout lead service-pipe is to be laid on to this sink from the down service-pipe from cistern H fitted with a screw-down horizontal bibcock. Also a similar ¾ in. stopcock is to be fixed in the service-pipe to the sink. The floor of this closet under the sink should be covered for a space of 5 ft. by the full width with 7 lb. lead, close copper-nailed round and across.

FIG. 18.



Note L.—The use of lead pipe for long lengths of bath or sink wastes on external walls is better avoided, unless expansion joints are provided above and below the junctions of all branch pipes into same.

158. *Sink* **KK** (Plan No. 6) is lead-lined and has a 1 in. waste-pipe trapped in itself. The sink is supplied from cisterns **P** and **Q** and the waste water is carried into soil-pipe **GG**. Occasionally the trap syphons out when closet **V** is used.

159. *Recommendations* (Plan No. 9).—Remove sink and provide a sink as described for sink **JJ**, and fix by window connected with waste-pipe **TT** and finished in all respects similar to **JJ**.

160. *Sinks* **LL, MM, NN, OO, QQ, RR,** and **SS** are all lead-lined and are of various sizes. Cold water is supplied from cistern **R**, soft water from cistern **Q**, and hot water from cistern **P**. All these sinks are immediately connected with the drain, the waste-pipes dipping into brick-built traps.

161. *Recommendations.* — The sinks marked **LL, MM, QQ, RR,** and **SS** are to be fitted with fire-clay enamelled sinks about 24 in. by 16 in., having 1¼ in. lead waste-pipes carried over external gullies and fitted with syphon traps with cleansing screws. Each trap is to have an anti-syphonage pipe as described for sink **JJ**. The cold services are to be taken from the 1 in. service-pipe from cistern **O** to the hot-water cylinder in the kitchen, with ¾ in. horizontal screw-down high-pressure bibcocks to each sink. A similar stopcock is also to be fixed in each service. Sinks **NN** and **OO** are to be of wood, with a division in the centre, about 3 ft. by 1 ft. 6 in. and 1 ft. deep. They are to be lined with pewter and in other respects are to be treated as the last excepting that there is to be in each division a brass washer and plug. Either side of these sinks is to be provided with a grooved draining board, the whole covered with pewter. The present service to small-feed cistern boiler in servants' hall must be re-connected to down service from **O**.

162. *Sink* **PP** (scullery) is a large stone sink (see note *O* in the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work) supplied from cisterns **R** and **Q**, the present arrangements of which have been described under cistern **R**. (See par. 129.)

163. *Recommendations.*—The scullery is to be partitioned off as shown on the amended plan No. 8 to form closet **E E** with open lobby and passage to the kitchen, the windows in

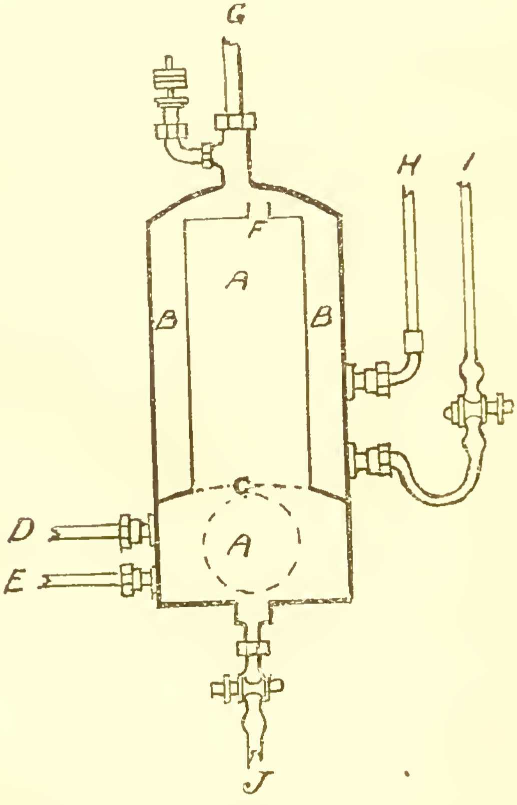
the scullery being now appropriated by the water-closet. A new one must be formed looking into the new side entrance passage to light and ventilate the scullery. The partitions are to be built of 9 in. brickwork. The interior of the scullery and the larders is to be cemented and lined with white glazed tiles, but the remaining portions of the partitions can be finished in plaster. The floor throughout should be paved with brick or Dutch tiles laid on a proper concrete bed. A small lean-to roof is to be placed as indicated on plan No. 9 to shield larder windows from the western sun, and an extra sash is to be fixed in the end larder. Provide and fix a glazed stoneware sink **PP**, 3 ft. by 1 ft. 8 in., placed on dwarf brick walls, with a 2 in. stout lead waste-pipe carried through the back wall chased in the same to deliver into flushing gully. Fix under the sink a lead syphon trap fitted with a brass cleansing cap and screw. A 1½ in. anti-syphonage pipe is to be connected just by the outgoing pipe of the trap and is to terminate externally; the end of the same is to be protected by a wire guard. Provide a ¾ in. screw-down bibcock and connect with a stout ¾ in. lead branch pipe from the 1 in. down service pipe from cistern **H.** A screw-down stopcock is also to be fitted in this short service-pipe. Provide and fix under the plate-rack a draining-board covered in pewter to drain into the sink. Should other sinks for washing vegetables be necessary they can be had in stoneware and treated in the same manner as the last, delivering by separate waste-pipe into the external gully.

Note M.—Where as in the present instance a biological filter is used the fat must be kept out of the drain or the filter will become clogged. An earthenware fat-trap gully must be substituted for the flushing gully and the accumulations removed and superficially buried at regular intervals.

164. *Hot Water System.*—There is a circulating system from the boiler in the kitchen to a tank fixed in the housemaid's closet on the first-floor half landing. The expansion-pipe is turned through the external wall (see par. 52 of the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work). A small supply cistern at the side of the tank furnishes the supply, being connected by a ball valve to cistern **P**; the overflow-pipe from this small cistern is connected into the waste-pipe of the sink above the trap. There are draw-off taps at the bath and to sink **K K** and all those on the ground-floor excepting in the servants' hall.

165. *Recommendations.*—Provide and fix in the recess at the side of the kitchen range a 50 gallon galvanised iron circulating hot water cylinder connected to the boiler by 1½ in. flow and return steam-pipe (see Fig. 23 in the previous report of THE LANCET Special Commission on the Relative Efficiency and Cost of Plumbers' Work). Carry up from the top of the boiler a 1¼ in. steam-pipe and bring the same through the wall of the chimney breast and fit with a dead weight safety valve. Fig. 19

FIG. 19 (Par. 165).



shows a Lawrence patent cylinder and its object is to limit the amount of incrustation in it and the pipes by using the water in the boiler only for the purpose of heating that in the cylinder. Its description is as follows: **A** is an internal chamber rising from a diaphragm **C**, below which are connected the flow-pipe **D** and return-pipe **E** from the boiler; access to this chamber is provided for by means of a manhole. **F** is an open tube passing up to within about half-an-inch of the top of the outer jacket of **B** and serves to connect the two chambers **A** and **B**, the pressure of water of course being the same in each. Though thus connected it is found in practice that the two waters do not mix to any appreciable extent owing to the variation of temperature causing a difference in gravity. **G** is the flow-pipe to the bath, &c., and **H** the return-pipe to the cylinder, **I** being the cold supply-pipe from cistern **O**. Through this arrangement, after the salts contained in the water in the boiler and in the heat interchanger or chamber **A** have been thrown down, comparatively little additional deposit takes place. The water, however, from this or from any other form of circulating apparatus cannot be regarded as having been sterilised by heat owing to the great pressure generally present necessitating a much higher temperature than is required in an open vessel to raise the water to the boiling point. The use of such a cylinder as above described is by no means a necessity where a steriliser is fixed (see par 130), as nearly all the salts of lime and magnesia will have been eliminated previously to the water entering the boiler. The 1¼ in. flow-pipe from the cylinder divides into two 1 in. steam pipes, one pipe passing along inside the front external wall of the wing and the other inside the back external wall, branches being carried down on each side to the several sinks; by this arrangement the presence of long lengths of branch pipes with dead water is avoided. Each sink is fitted with a ¾ in. gun-metal high-pressure, screw-down, horizontal bibcock. These two flow-pipes again unite at the end of the passage and pass up through the lavatory, housemaid's closet, and along the wall of the passage on the first-floor to the best bath-room, with branches to this bath, and the one on the second floor also to lavatory, servants' bath, and two housemaids' sinks, which last are provided with ¾ in. screw-down bibcocks like the others. The flow is continued up through the new housemaid's closet and is returned by a single pipe into the cylinder. An expansion pipe is carried from the highest point and is turned over cistern **I** in the cistern room. Provide a small expansion cylinder in this pipe above the level of the top of the cold-water cistern.

166. *The Best Bath* is composed of zinc enclosed by a mahogany framed casing. There is a lead safe below, the waste-pipe from which passes into the side of the D-trap of water-closet **T.** The bath waste-pipe is fitted with a running trap formed in the 1¼ in. waste-pipe and is then connected with soil-pipe **D.** The bath has a hot and cold supply, the latter from cistern **H** and the former from the hot-water tank in the housemaid's closet; this supply is very sluggish, the head of water in the hot-water tank being but little above the bath. The supplies enter at the sides through two 1 in. plug stopcocks under the bath. These are worked by iron rods and lever handles. Owing to the cocks leaking and the inside of the bath becoming rusty the lead pipe between the cocks and the inlet to the bath has been punctured to allow of the escape of any water passing the valves when shut, occasioning considerable waste of water.

167. *Recommendations.*—Disconnect the bath, make good the inlets, and fit a plug waste in the bottom of the bath; re enamel and re-use the bath in the servants' bath-room. Disconnect the waste-pipe of the safe from the D-trap which is to be removed and carry a 1½ in. lead waste-pipe through the external wall to deliver into the open air. Fit a copper flap-valve at the end of the pipe. Provide a new full-sized parallel enamelled copper bath and fix it with a vulcanite plug and plated fittings to the waste-pipe connected to the 1¼ in. lead pipe and running trap; the waste-pipe is to be carried into waste **UU** from sink **JJ.** Take from the out-go of this waste-pipe a 1¼ in. lead anti-syphonage pipe carried through the external wall fitted at the end with a copper-wire guard. Provide hot and cold overhanging screw-down plated cocks and connect with 1 in. galvanised iron pipes respectively from the down service-pipe from cistern **O,** and the hot-water system each fitted with screw-down stopcocks near the bath. Supply and fit a new mahogany bath top, refix bath casings and make good the floor, walls, and skirtings. Provide and fix a 1¼ in. plated overflow at foot of bath having a lead waste carried through external wall, the end fitted with a copper flap-valve.

168. *Second, or Visitors' Bath.*—Supply an independent cast iron best enamelled bath, with plug waste properly trapped with anti-syphonage pipe carried through external wall and connected into that from best bath. Fix wood fillet on floor and cover space under bath with 7 lb. lead. Carry 1 in overflow through external wall, the end fitted with a copper flap valve. Lay on 1 in. galvanised iron service

from down service from cistern **O** fitted with screw-down stop-valve by bath. Supply screw-down overhanging plated bib-valve at foot of bath and connect to same, also a similar valve for hot water and connect with 1 in. galvanised iron service from hot-water circulation, fit overflow grating to foot of bath and carry ½ in. short lead pipe to project through external wall—the end fitted with a copper flap-valve.

169. *The Servants' Bath.*—Provide a lead safe with a 1½ in. waste-pipe carried through the external wall, fix the old zinc bath and fittings taken from the principal bath-room, carry a 1¼ in. lead waste-pipe **TT** into waste of sink **KK** and fit a running trap in the same with an anti-syphonage pipe as in the last bath. Provide lead safe and waste into open. Lay on overhanging hot and cold supply-pipe with brass screw-down bibcocks, each service provided with stopcock as last. Provide deal top and matched boarded enclosure to bath, fitted with door for access to safe.

Note N.—Happily the greater facilities for cleanliness now provided in the homes from which domestic servants are taken, together with similar opportunities offered in houses where they are employed, is producing a taste for more healthy habits among this class than prevailed formerly. It is not at all uncommon to find members of the families of the better class of mechanics who have never had a bath that they can remember unless owing to the accident of illness. The condition of these people when becoming inmates of a hospital proves this frequently.

170. *The Lavatory.*—After the alteration to the cloak-room has been carried out provide and fix under the window with moulded edge a white marble slab 1½ in thick, the full length of opening by 1 ft. 9 in. deep fitted with two oval lavatory basins under the same, with a separate 1 in. overflow-pipe carried through the external wall to deliver over gully. Provide and fix a pull-up waste valve and connect a 1¼ in. drawn-lead syphon trap under each basin and continue the waste-pipes through the external wall to deliver into gully. Provide a 1 in. anti-syphonage pipe from the outgoing pipe of the traps to finish externally, the end being fitted with a cross-wire guard. Lay on 1 in. galvanised iron cold supply-pipes fitted with overhanging cam action plated bibcock and connect a 1 in. branch pipe from the hot-water service pipe to similar bibcocks. Provide 1 in. stopcock as before described in each service-pipe.

Note O.—It is very desirable that each internal closet should be approached by a ventilated lobby, but this in all cases is not obtainable. A more complete plan than the one adopted would have been to build an annexe at the back of the house to contain all the closets and the bathrooms, but this would not have been so applicable to the general requirements of the public.

THE WATER-SUPPLY.

171. *Existing Water-Supply.*—There is a constant spring from the hills some 300 ft. above the house, the water from which is collected in a reservoir 150 ft. lower down. The overflow from this reservoir falls into the lake, the stream through which then passes on through the village which is a mile distant. This reservoir is silted up and requires thoroughly cleaning, embanking to exclude surface water, and fencing round. (See Water-storage, par. 53, &c.) The service-pipe to the mansion has only a 1½ in. bore and is altogether inadequate to the requirements. In addition there is a deep well by the bailiff's house and there is another at lodge No. 5, whilst a shallow well supplies lodge No. 8. (See plan No. 12.)

172. *The Main Supply.*—Form a brick chamber 3 ft. by 3 ft. 6 in. and of the necessary depth at the side of the reservoir to form a manhole for a stop-valve in the main. Connect into the reservoir 6 in. from the bottom at this point a 4 in. heavy cast-iron main laid with the usual molten and caulked lead joints carried to a point about 20 ft. from the north-east angle of the building, where it divides into two 3 in. branches, one passing along the south-west front of the house as far as the end of the kitchen wing and tho other along the garden or north-east front to a hydrant at the extreme corner of the stables. From this point a 2 in. main-pipe is carried at the side of the road past the greenhouse as far as the farm buildings, where another hydrant is to be fixed. This main must be laid in a trench at least 3 ft. deep, it must be carried in a straight line from point to point, and be (see par. 41) of even fall throughout. In the immediate neighbourhood of the house and buildings and wherever passing through made ground it must be laid upon a 6 in. concreto bed. This main pipe will have 2 in. branches to hydrants fixed at suitable points all round the house at about 20 ft. or 30 ft. from it. A 2 in. strong lead branch pipe will also be carried up to the level of the second floor to a point outside water-closet **S**. Two other points will be provided, one in the cloak-room and the other by the doorway in the passage on the first floor connecting the main and the wing buildings. These points will be fitted with handy straightway lever valves (Fig. 3) and the usual hose and connexion. A ¾ in. stout lead branch rising main will be continued from this main to supply cisterns **O** and **P** fitted with equilibrium ball valve.

SUMMARY OF EXISTING ARRANGEMENTS FOR THE DISPOSAL OF SEWAGE.

173. *The House, Stables, and Laundry* (see plan No. 12).—There is an entire absence of any regular plan of drainage, the house having under and around it a number of cesspools the overflows from which are carried into the surface-water drain from the garden paths, which last eventually delivers into a ditch running at the side of the avenue and falling into the stream that feeds the lake. The bulk of the solid matter is caught by the cesspools, while much of the liquid soaks into the ground from the defective drain and during its lengthy passage in the ditch, but little fortunately reaching the lake excepting during heavy rains.

174. *The Gardener's Lodge* (*No. 5*) *and Farm Buildings* drain into the ditch on the north-west side of the road.

175. *The Bailiff's House* (*No. 6*) has midden closets, and the surface drains run into a ditch.

176. *Kitchen Gardens'* surface drains run into the pond in the garden.

177. *The Keeper's Lodge* (*No. 8*) drains into a cesspool.

178. *Recommendation.*—The general system of proposed drainage is as follows, the details being given under different heads.

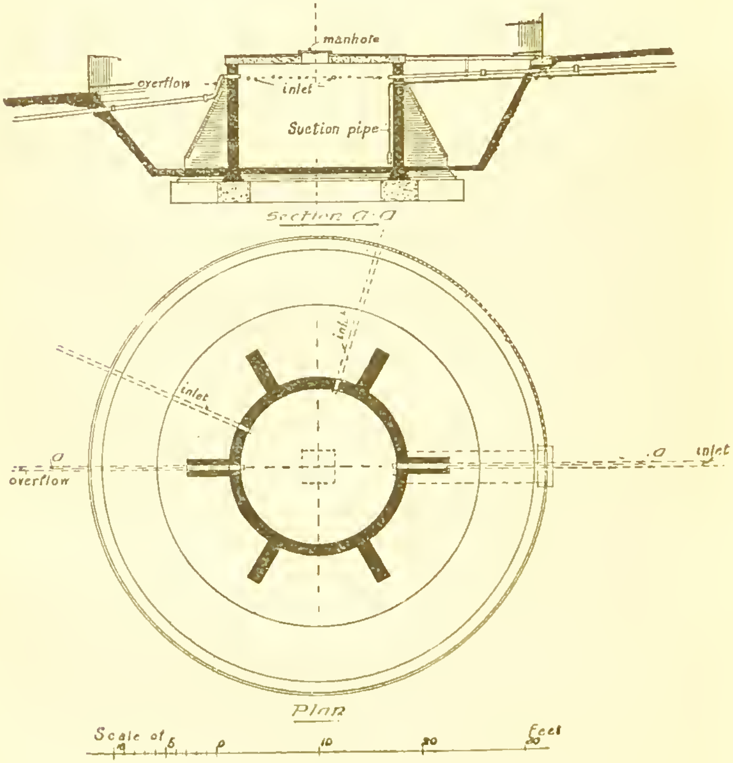
179. *The several Soil Drains* round the house (see plan No. 11) are collected in a disconnecting chamber marked 9 on plan No. 12 (see also Fig. 21); a drain passes under the terrace road to a point opposite the entrance to the stables; here it turns almost due west and joins the back road by lodge No. 5. From this point it runs in a direct line to the Moncrieff cultivating tank **E**. In its course it receives the soil drain from the laundry and stables, Nos. 2 and 3, and the connexion with the pond, lodge No. 5, and farm buildings No. 7. Further details relating to these buildings will be found under separate headings.

180. *The Surface Drains* are formed entirely separate from the last and are collected so as to deliver half into the pond in the kitchen garden, while half passes into the hawhaw adjoining the drive. From this pond an overflow-pipe is carried into the ditch on the north-west side of the back road. There is also a connexion, fitted with a disconnecting

chamber and sluice valve, between the pond and the main drain, to be used occasionally for flushing purposes. The rain-water overflow and the surface drains in the basement of the house deliver over gullies in connexion with this surface drain.

181. *The Rain-water Drains.*—Before discharging the rain-water into the storage tank it should be passed through a sand and gravel filter that will free it from any gross impurities which may have accumulated during the process of collection. The illustration (Fig. 1) shows a simple form of construction for this purpose. It will be necessary to provide a storm overflow for the ready escape of any large body of water which would be unable to pass through the filter.

FIG. 20.



182. The plan (Fig. 20) shows a good form of rain-water reservoir, but in the event of another suitable supply being available it would be undesirable to entail the outlay necessary for its construction. In the present case it is given simply as an illustration. The use of the steriliser marked Z on plan No. 8 provides a soft water equal to all requirements and the collection of rain-water is unnecessary. The plan and section (Fig. 20) sufficiently explain the principal details. This reservoir consists of a circular tank built in brickwork in cement supported by buttresses, the bottom of which is kept a few inches above the level of the surrounding area. The tank is covered over on the top, in the centre of which is fixed a ventilated louvre manhole—the whole is lined with Portland cement. Access to the tank is had by means of a short foot-bridge, which also carries the main inlet drain. The whole is surrounded by a light railing.

NOTES ON THE DRAINAGE SYSTEM.

183. *The Levels.*—The first consideration of any system of drainage is one of levels, and where irrigation is to be adopted a fall of a few additional feet will be required. A large house, for instance, like the example given would need a fall of from 25 ft. to 30 ft., and as a rule this class of house is so situated as to admit of such a fall being available. If this is not the case a small cesspool or sump must be formed and the sewage must be raised by an elevator with the best power available. The fall will be divided somewhat as follows :—1. From the house to the cultivating tank, with an allowance for falls in disconnecting chambers, say a 500 ft. run of drain with a minimum fall of 1 in 60 = 10 ft. 6 in., commencing at a depth of 12 in. at the highest point below the ground line. 2. The depth of the cultivating tank and the storage reservoir with the fall for the drain between would amount to 9 ft. 6 in. 3. The land to be irrigated should have a fall, however slight, and the subsoil drains, which will be laid about 2 ft. or 3 ft. below the ground line, must have a slight fall ; this may be taken altogether at not less than 5 ft. 4. Beyond this a subsidence pond is desirable from which an overflow passes into a stream or ditch ; this may be put at 2 ft. In connexion with this overflow not only must the normal level of the stream be considered, but also its possible rise when in flood. At this point, under some cir-

cumstances, it may be desirable to provide a gully fitted with a float-valve to check the back flow. The rain-water from the house and the grounds, it is remembered, is dealt with by a separate system, where a less total fall is required. The total of these falls is made up thus: No. 1, 10 ft. 6 in.; No. 2, 9 ft. 6 in.; No. 3, 5 ft.; and No. 4, 2 ft.; the total fall being 27 ft. In order to economise the fall, most of which is required at the extreme end, it may sometimes be necessary to support the main drain upon a brick wall or embankment, or even upon a stout tressel rustic viaduct, when passing across some depression of the contour line of the ground. Of course, in such cases heavy cast-iron drain-pipes would be used.

184. *The Size of the Drain.*—It is a mistake to use too large a drain; one of 6 in. diameter will generally suffice for the requirements of the largest house, a small drain being more readily kept free from deposit.

185. The following table[2] from some calculations made by Messrs. W. Santo Crimp and A. M. Bruges shows the inclination to be given to circular pipes flowing full or half-full in order to produce a velocity of flow equal to 3 ft. per second, together with the discharge in gallons per minute when flowing half-full.

Diameter of pipe.	Velocity per second.	Inclination.	Discharge (half-full) per minute.
4 in.	3 ft.	1 in 62	49 gallons.
6 in.	3 ft.	1 in 107	110 ,,
9 in.	3 ft.	1 in 183	248 ,,
12 in.	3 ft.	1 in 269	441 ,,
15 in.	3 ft.	1 in 362	690 ,,
18 in.	3 ft.	1 in 462	993 ,,

In providing for the removal of surface water the following tables are generally accepted, but the great variation in the amount of rainfall in different localities renders it impossible to offer any universal rule in this matter.

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[2] The Builder, August 6th, 1896.

Quantity of Rainfall per Acre.

Inches.	Cubic feet.	Gallons.	Inches.	Cubic feet.	Gallons.
0·1	365·0	2,262	0·6	2178·0	13,573
0·15	544·5	3,393	0·65	2359·5	14,704
0·2	726·0	4,524	0·7	2541·0	15,836
0·25	907·5	5,656	0·75	2722·5	16,967
0·3	1089·0	6,787	0·8	2904·0	18,098
0·35	1270·5	7,918	0·85	3085·5	19,309
0·4	1452·0	9,049	0·9	3267·0	20,360
0·45	1633·5	10,180	0·95	3448·5	21,491
0·5	1815·0	11,311	1·00	3630·0	22,622
0·55	1996·5	12,442			

Provision for Surface Water at Per Hour.

From	roofs		0·5 in.
,,	flagged surfaces		0·2 ,,
,,	paved ,,		0·1 ,,
,,	gravel ,,	clay subsoil	0·05 ,,
,,	,, ,,	gravel ,,	0·01 ,,
,,	grass ,,		0·02 ,,

186. *The Old Drains.*—All old internal drains must be carefully traced to see whether they lead to any cesspool and must be removed, together with any contaminated earth. Even external drains should be carefully removed, as they may contribute to the pollution of water.

187. *Made Ground.*—In made ground all pipes must be laid upon a 6 in. bed of concrete.

188. *The Drains under Walls.*—All drain pipes passing through walls must be protected by a brick arch or stone lintel, to provide against fracture from settlement in the house.

189. *The Cellars and Areas.*—Cellar or area drains should deliver over an external gully; in fact, open channels should be substituted for drains in cellars. These channels can be readily kept clean, whereas with drains the traps frequently remain for long periods without being re-charged and the result is that the water either evaporates or smells badly. Where these channels are made to deliver over an external

gully in connexion with a soil drain the water from a sink or bath should be arranged to deliver over the same gully, so that the water in the trap may be frequently renewed. An iron grate should also be fixed in the aperture through which the channel passes, to exclude vermin. It generally suffices to allow the small quantity of water from this source to soak away into the ground a short distance from the house instead of being connected into the drains.

190. *Ventilation.*—Long lengths of drain should always be ventilated at intervals by 3 ft. open chambers having half channel bottoms with iron gratings at the ground level; in fact, the closer a drain approximates to an open channel the better. This is very important where the drain is small, say 4 in or 6 in., for should such a drain run full bore when badly ventilated there is great resistance from the compression of the air in front of the flow due to friction and also owing to the vacuum created behind the charge, and there exists a strong tendency to syphonage in the traps. The main 6 in. drain from the disconnecting chamber must be ventilated on the outlet side of the trap by a 6 in. branch pipe carried to some convenient part of the building and continued up above the roof, either in a 4 in. lead 8 lb. soil-pipe or in a 5 in. stout iron galvanised pipe with caulked leaded joints.

191. *Iron Ventilating Pipes.*—The use of iron for ventilating pipes, unless galvanised, is not to be recommended, as drain air rapidly rusts and corrodes them. In the case of a drain- or soil-pipe this action does not take place, the greasy constituents in the sewage forming a protecting coat.

192. *The Surface Water.*—When plans are formed for the treatment of the drainage of a large country mansion an endeavour must be made to reduce as much as possible the quantity of water poured into the soil drain. Apart from the absurdity of needlessly fouling water which has afterwards to be purified the value of the sewage as a manure will be reduced and more land will be required for irrigation. To do this a separate drain must be provided to take the surface drainage from all courtyards, paths, and rain-water overflows round the house and buildings. If possible, avoid crossing these two sets of drains or otherwise bringing them into close proximity, but should it be necessary to cross them the surface water drain must be kept above the soil drain, lest any leakage should occur in the latter at these points and so enter the surface drain.

193. *The Surface Water Pond.*—Where possible this water should be collected in a pond or reservoir (in this case situated in the kitchen garden); the overflow can be carried into the nearest ditch. A brick disconnecting chamber is to be built at the lower end of the pond, in which is fixed the usual trap and channel, and from which a branch-drain is connected into the main drain. A sluice valve or penstock is fitted in the inlet to this chamber. The advantage of this will be fully appreciated not only in the dry season and when it is desirable to give a less concentrated dressing to the land, but also in the winter when the ground is already saturated with moisture. The control of this body of water will also be of advantage for the occasional washing of the storage reservoir of the soil drain.

194. *The Rain-water Drain.*—If the rain-water which falls upon the house is not utilised it must be carried into the surface drain. In any case, even with a cesspool, the surface water must be treated separately. To obviate the necessity of much deep digging it is better to have the highest point of the drain, say, 12 in. below the surface of the ground instead of below the cellar floor. As already mentioned a separate drain should take the waste water from the cellars and areas, carried out in the direction of the slope of the ground and made to deliver over a gully in connexion with the surface water drain or into the nearest natural outlet.

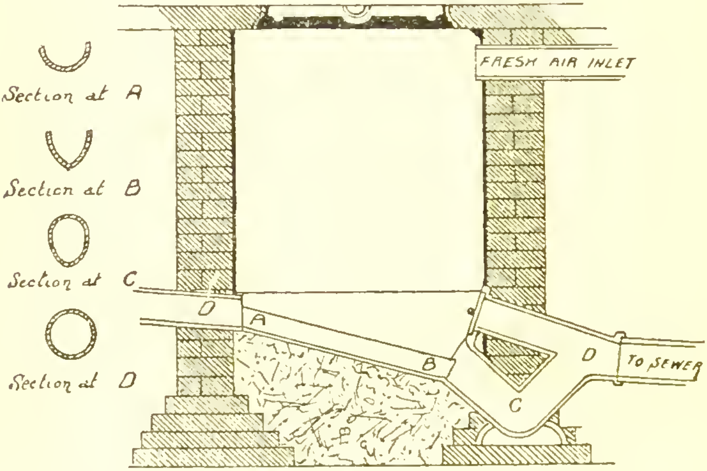
195. *The Soil Drain.*—The soil drain will, of course, be kept entirely outside the house and conducted into a disconnecting chamber (Fig. 21) in the usual way, but in all cases at its extreme end an automatic flush tank should be provided to discharge at least 50 gallons of water every twenty-four hours.

196. *The Flushing Tanks.*—The flushing tanks must be proportionate in capacity to the length of the drain which they are intended to flush, as, owing to the friction in the small drains now used, in a long drain the initial force of the discharge is soon reduced, the central body of water rapidly passing away in a gradually attenuated stream, while that portion in contact with the pipe slowly follows.

Note P.—In the example given some difficulties present themselves in providing a flushing tank for each head of the two soil drains, terminating as they do at the principal façades of the mansion. Three alternatives offer:—1. To sink the drain some 4 ft. deep in order to allow of flushing-tanks being built below the ground, in which case they might be charged through a disconnecting cistern fixed in one of the outbuildings. 2. By carrying up drains to the higher ground on the north-east corner and there placing the flushing-tanks. 3. By placing the two flushing tanks in the cistern room and bringing down a 2½ in. discharge-pipe from each to deliver over gullies fixed by wall at the head of each drain marked 10 on plan No. 11, the gullies to have large mouths carried up 2 ft. 6 in. above the ground level, with gratings on top. This plan is shown in the example. The waste from sink J J also discharges into one gully and re-charges the trap, affording an additional protection should the syphon in the cistern fail to act. This precaution, though desirable, is not an absolute necessity.

197. *The Fall of the Main Drain into the Sewage Tank.*—The drain must be laid on a concrete bed at a regular fall throughout. The fall will be regulated by the difference in height between the disconnecting chamber and the sewage tank, which in this case should be capable of holding some 10,000 gallons. If from the nature of the ground it is necessary to make any deviation from a straight line then an inspection chamber must be built at the angle thus made or at any point where a branch drain from the stables or other buildings may enter it. In Rawlinson's "Suggestions" it states that branch drains should have a fall into the main drain at least equal to the difference in their sectional diameter. No branch drain should be connected at right angles with the main drain but should have an inclination in the direction of the fall, with an inspection chamber or eye at

FIG. 21.



Disconnecting chamber.

every such junction. Levels must be carefully taken and the trench must be made from end to end before laying the drain, for which purpose the use of sight rails will be found to be very advantageous. The main drain should always be first laid and all branches should have a fall at least equal to that of the main drain, if possible a greater velocity should be given in the case of these drains, as it will tend to accelerate in place of retarding the flow at such junctions.

198. *The Cultivating Tank.*—Just before this main drain enters the cultivating tank (**E** on plan No. 12; also see par. 92) another disconnecting chamber must be built with a syphon next to the tank. The usual iron cover is to be replaced by an iron grating. In addition to this, in some isolated spot a long, narrow chamber, 4 ft. or 5 ft. in length, should be formed in the course of this main drain; the chamber should have a half channel bottom, and the whole be covered with an iron grating. This will completely isolate the house from the cultivating tank. This tank is made with two chambers, each resting alternately. Finally, the effluent passes into a storage or sewage tank **F**, whence it is passed periodically on to the land either by means of a syphon or penstock. With the microbe cultivating tank the clear effluent permits of the use of a very much smaller plot of land than would otherwise be allowable. The River Pollution Commissioners assume a unit of 2000 persons per acre, but this quantity with crude sewage, unless the soil is in every way favourable, must be considered excessive. Where the sewage is in a liquid state from some previous treatment the late Dr. Tidy gave from 5000 to 7000 persons per acre. Where there is plenty of land available it would be wise to disregard any calculation based upon the above figures and to devote at least an acre of land to every 100 of the population with a due allowance for each animal in the farmyard and stables. For the intermittent system the area of land should be divided into a number of compartments, so that the sewage may be allowed to flow on to each part in turn as required. If the land devoted to the purpose is on the side of a hill the catch-work system is well adapted to the purpose, the water flowing over a succession of made terraces. Upon nearly level ground the arrangement shown on the Estate plan No. 12 will be found convenient, but in any case the greatest care must be exercised to ensure that the surface over which the water flows is free from all obstruction and that there are no hollows where the sewage can stagnate and spoil the results by the production of rank vegetation. The first things to

be considered are the subsoil drains (see Estate plan No. 12); the depth at which they are laid and their distance apart must depend upon the nature of the soil (see table by Mr. Dempsey).

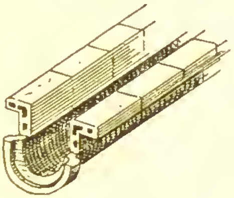
Drainage of Land

Character of soil.	Distance of drains apart.	Depth of drains.
Heavy soils.	ft.	ft. in.
Compact, tenacious, gravelly clay ...	15	2 6
Stiff adhesive clay	16½	2 6
Friable clay	18	2 9
Free soft clay	21	2 9
Medium soils.		
Clayey loam	22	3 0
Marly loam	24	3 0
Gravelly loam	27	3 3
Friable loam	30	3 3
Light soils.		
Light gravelly loam	33	3 6
Light marly loam	36	3 9
Light sandy loam	39	4 0
Soft light loam	42	4 0
Sandy soil loam	45	4 0
Light gravelly sand	49½	4 3
Deep gravelly sand...	55	4 3
Coarse gravelly sand	60	4 6
Loose gravelly sand	66	4 6

An average depth is about 3 ft. 6 in. with a distance apart of some 30 ft., and the number of 12 in. agricultural drain-pipes required varies from about 3000 to the acre in the heaviest soils to about 650 in the lighest. The main outlet should be conducted into a reservoir (marked **H** on plan No. 12) in which the effluent water is allowed to subside before it overflows into the stream which is to receive it. This water, if the irrigation is properly conducted, will be (if not immediately suitable for drinking) very far advanced towards a state of purity.

The amount of liquid sewage finally collected is calculated at about 1500 gallons per day, being the maximum probable amount. Now each dressing to the land should not be less than about 1 in. over the whole surface, and this would be equal to 22,622 gallons per acre. The plot of about 2¾ acres on the plan is divided into eleven parts of ¼ acre each. It will therefore be necessary to collect 6750 gallons, or nearly five days' supply, of sewage effluent in the tank **F** in order to flood one plot. This will allow an interval of a little less than three weeks before it will be necessary to administer a second dressing to any one plot. This again will depend upon the number of people in occupation; as a rule the late autumn and winter months are those in which these houses are most fully occupied. These being the months during which the ground is most saturated it may be desirable that the amount of land devoted to irrigation should exceed the limit just proposed. Of course, the nature of the crop grown on the several plots will determine the question as to how frequently the dressing should be repeated. There is a 5 in. cast iron pipe carried from the bottom of the storage tank as far as G, where it is fitted with a "Handy-straightway valve." The plots are divided by the main carriers, which are better if fitted with half-round, glazed channel bottoms about 9 in. wide (Fig. 22). The sides also may, if preferred, be lined with glazed earthenware bricks especially made for the purpose. Sluice valves must be fixed at various points in order to divert the stream over each plot as desired, or this may be done by simply cutting off the channel by means of a piece of stout sheet iron driven into the earth across the main carriers if these are not lined. There are numberless ways in which irrigation can be applied, and the methods will vary according to the situation of the land to be devoted to the purpose. Its ready application will frequently tax the ingenuity of the individual adapter, but enough has been said to show that it is a matter of great simplicity and undoubtedly the only way in which all sewage should be disposed of where the water carriage system is adopted. With an institution holding a constant resident number of inmates there is less difficulty in regulating the several factors tending to a satisfactory result. It is difficult owing to the limited space at disposal to go fully into the varying possibilities of every case, but no insuperable difficulty will be experienced if the following

Fig. 22.



Main carrier.

points are kept in mind: (1) the nature and permeability of the soil, regulating the depth of the subsoil drains; (2) the crops intended to be grown; and (3) the possible amount of sewage and if it is likely to vary to any great extent, together with the probable season of such variation.

199. *Drains Under Roads.*—Should any drain be laid along or cross under a road precautionary measures must be taken to protect it from damage by heavy traffic.

200. *Disconnected Pipes.*—All sink and other waste pipes should deliver over half-channel pipes before running into gullies.

TREATMENT OF BUILDINGS THAT ENVIRON THE MANSION.

201. *The Lodges.*—Each cottage or lodge to be connected with the system must be treated as a detached house and have a separate disconnecting chamber. The bailiff's house and the lower lodge, being situated in depressions below the level of the drain outfall, will be treated differently.

THE LAUNDRY.

202. The drying yard should be turfed throughout and the gullies in the several paths should be connected into the surface drain, for the smaller the area of ground which is paved the fewer are the opportunities for accumulations of offensive matter. Any foul water falling upon the living earth such as grass land is at once purified, but the same falling upon a paved surface escapes through fissures, under more or less pressure, to the earth below and has to depend entirely upon mechanical action to restore its purity. There need be no drains within the laundry but channels should be provided in order that the floor may be kept thoroughly dry. Square fireclay tubs are considered to be the most satisfactory in every way, but as they absorb a large amount of heat from the water in the first instance there must be a very efficient supply of hot water. External gullies must be provided to take the wastes from these tubs, the drain from which discharges into a disconnecting chamber. A closet is to be formed and fitted in this

laundry in all respects the same as closet **EE** in the mansion but with a white glazed trap, and a separate drain from this closet is connected into chamber having a 3½ in. 10 lb. lead ventilating pipe carried up above the highest point of the roof and clear of all windows. The laundry is divided from the stables by a 14 in. brick wall which runs longitudinally through the building, the rooms on the first-floor being used for drying and ironing. The rain-water falling on these buildings, which cover a considerable area, is collected in the main rain-water tank after passing through a filter. (See Fig. 1.) Provide and fix a 300-gallon galvanised iron cistern in the first floor with overflow through external wall, carry down a ¾ in. warning-pipe to pump.

Note Q—In cisterns charged by pumps a "warning-pipe" is commonly fixed. It consists of a small pipe connected into the cistern just below the level to which the cistern is to be filled, the other end of the pipe terminating close to the operator at the pump. The operator watches the end of the pipe and the first sign of water escaping warns him to desist from pumping.

Provide and carry to this cistern a 1½ in. galvanised iron rising main from pump. Soft water acts very readily upon lead and iron pipes, so that either galvanised iron or copper tubes must be used for the hot-water circulation to the tubs, copper being the best, as there is always a certain amount of risk of iron-mould to the clothes where iron is used for hot water, even if it is galvanised. (See pars. 10 and 44.)

A copper dome-top boiler is to be set in brickwork with 1 in. copper flow and return pipes carried round the walls of the laundry to a small copper supply cistern which is fixed at the extreme end of the circulation. From the flow-pipe short supply-pipes are brought down to the tubs, these pipes being fitted with horizontal bib-valves. Provide and fix a dead-weight safety-valve to the boiler. Lay on a ¾ in. block-tin or copper pipe for supply to feed the cistern from the cold soft-water cistern. Carry a similar cold 1 in. service-pipe from the same cistern to supply each of the tubs. Carry to this soft-water cistern a ¾ in. lead supply-pipe from the main in the road fitted with a ¾ in. high-pressure ball-valve and screw-down stopcock as a supplemental supply. In addition to the above a ¾ in. short branch pipe is brought off the main and is carried to one of the tubs, being fitted with a screw-down bibcock and having a ¾-in. screw-down stopcock fixed in the service-pipe just above the draw off.

THE STABLES.

203. The stables should be drained with cast-iron channels and covers made to deliver into the open air over a gully. The drains from the water-closets, sinks, gully, &c., will be made to meet in a disconnecting chamber and will be ventilated in the usual way, together with the upper end of the main branch from the sewage tank.

GARDENER'S LODGE No. 5.

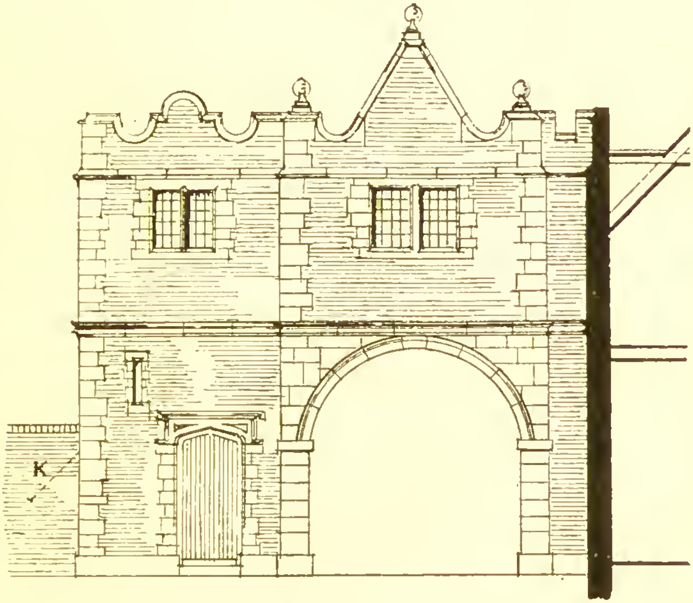
204. *Recommendations with regard to the Gardener's Lodge, No. 5.*—The existing open midden in the garden is to be cleared away and filled in with dry ground. Build upon a proper footing in 9 in. brickwork a lean-to building to form a new water-closet, 4 ft. 6 in. by 3 ft., the inside measurement being at the lowest point 7 ft. 6 in. high. Provide a window in the end, fitted with a casement sash measuring 3 ft. by 2 ft. glazed with obscured glass. Provide a ledge door and frame, 6 ft. 6 in. by 2 ft. 6 in., with an oak sill. Form a lean-to roof covered with slates. Form a Portland cement floor laid on a 3 in. concrete bottom. Provide and fix a short flushing rim hopper closet and carry a 4 in. stoneware pipe drain into the disconnecting chamber. Supply and fix a properly hung deal seat. Twice limewhite the closet walls. Supply and fix upon suitable brackets a 3-gallon galvanised iron flushing tank and lay on a ½ in. stout lead branch service-pipe from the slate cistern in the scullery, this being fitted with a ½ in. ball-valve. Continue the short overflow-pipe through the external wall. Lay on a supply to the arm of the closet with a 1½ in. lead service-pipe, properly fixed with cast-lead tacks, from the flushing cistern.

205. *Sink and Supply to same.*—There is a stone sink in the scullery with a brick drain under it leading into the ditch on the other side of the road. A slate cistern (100 gallons) is fixed in the scullery to supply this sink. There is no overflow-pipe, but a warning-pipe (see Note Q.) is carried to a pump fixed over a deep well. This pump is worked by horse power and supplies water for the gardens and farm buildings, being taken to the two last in a water-cart.

206. *Recommendations.*—Replace the old stone sink by one of glazed stoneware. Provide and fix a 1¼ in. lead syphon trap under it (see Fig. 18) and carry the waste-pipe through the external wall to deliver over a new gully. Disconnect the

present supply from the pump and connect into the nearest point of the new main in road a $\frac{3}{4}$ in. stout galvanised iron service-pipe fitted with a $\frac{3}{4}$ in. equilibrium ball-valve. Remove the warning pipe and instead carry a $1\frac{1}{4}$ in. overflow-pipe through the external wall.

FIG. 23.



Front Elevation

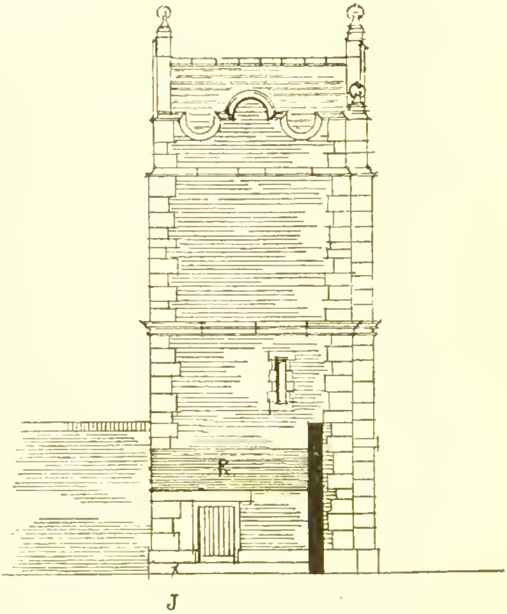
THE BAILIFF'S HOUSE.

207. The bailiff's house (No. 6 on plan No. 12) is of much earlier date than the mansion, and is situated in a hollow; the whole of the drainage will have to be dealt with locally; the system adopted will be that recommended by Dr. Poore, which can here be well exemplified.

208. *The Present Arrangements of the Bailiff's House.*—The water-supply is from a well about 60 ft. deep, which is fitted

with a windlass and buckets. There are two midden-closets in the garden which are built over a ditch which is dry excepting in times of heavy rain. The sink in the scullery has a short lead waste-pipe connecting into a brick drain, which is carried into a cesspool in the garden. A pan closet on the first-floor landing is connected into cesspool by a 4 in. iron rain-water pipe. The cistern over closet is charged by rain-water from valley gutter of roof with a 3 in. zicn

FIG. 24.

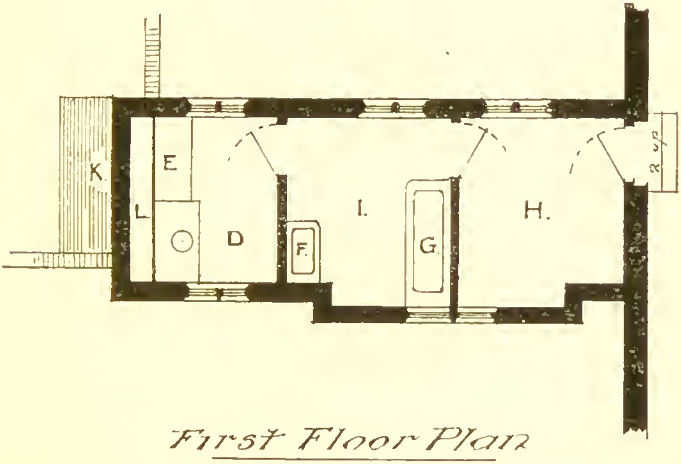


Side Elevation.

standing waste carried into side of D-trap of closet. There is a supplemental supply to charge this cistern from the pump in scullery. There is a short system of brick drains under the kitchen wing which take water from the brick floors and yard gullies, eventually delivering into the ditch. There is thus an easy communication for rats to the interior of the house.

209. *Recommendations.* — The water-closets, bath waste water, and bedroom slops are treated separately, as also is the waste water from the sinks. The present closet in the house, which is connected into the cesspool in the garden, is to be entirely removed and the walls of the cesspool are to be broken down, the whole being cleared away and the opening filled in with earth. A small annexe is to be built, as shown (Figs. 23 and 24), connected with the main building by a short corridor provided with cross ventilation. The upper portion (Fig. 25) consists of a bathroom and closet with sink, whilst below (Fig. 26) is another closet for the use of the domestics, access being had to the same through the arch supporting the corridor which thoroughfare is thus protected from wet. The illustrations, which are adapted from those in Dr. Poore's book upon Rural Hygiene, will clearly indicate the details. The points to be particularly noticed are the cross ventilation of the lobby to the closet and also of the capacious dry catch; the ventilation of this last is effected by the iron gratings in the wall and by the brick flue at the back of closet (see Fig. 9). The seat of the closet is only 14 in. above the floor line in place of the usual 18 in. This is a

FIG. 25.

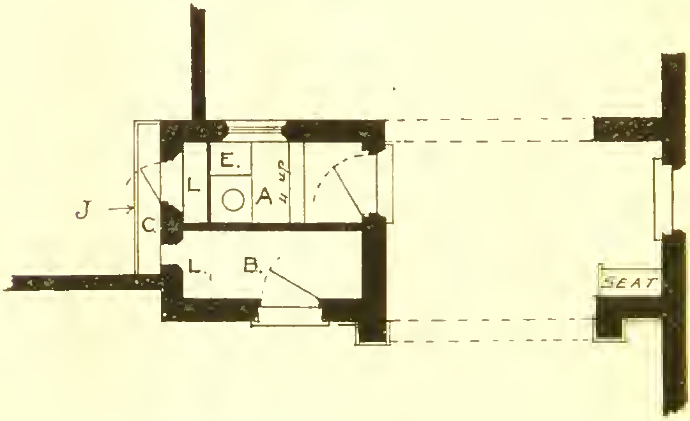


D, Closet. **E**, Earth-box. **F**, Sink. **G**, Bath. **H**, Lobby with cross ventilation. **I**, Bathroom. **K**, Lean-to roof to exclude rain from **C**. **L**, Ventilating shaft open at roof.

very important point, as when the closet is used the dejecta fall perpendicularly instead of being thrown against the pan. There are also certain physiological advantages from the position assumed by the user of the lower seat which are absent in the other.

The pan, which may be constructed either of earthenware or metal, is provided with a straight back and is fitted with a flap-valve which is so adjusted by a counterbalance weight that it permits the excreta and earth to fall at once into the catch below, at the same time excluding any up draught (see Fig. 27). The floor of the catch is cemented and the door to it has a space at the bottom of some 4 in., which is filled with fine wire netting, so that air may freely enter and all small animals may be excluded. One or two shovelfuls of dry "living" earth taken from the surface of the ground are thrown on the floor after each removal of the contents of the catch. (Earth taken from below the surface is dead and exerts no humifying influence.)

FIG. 26.

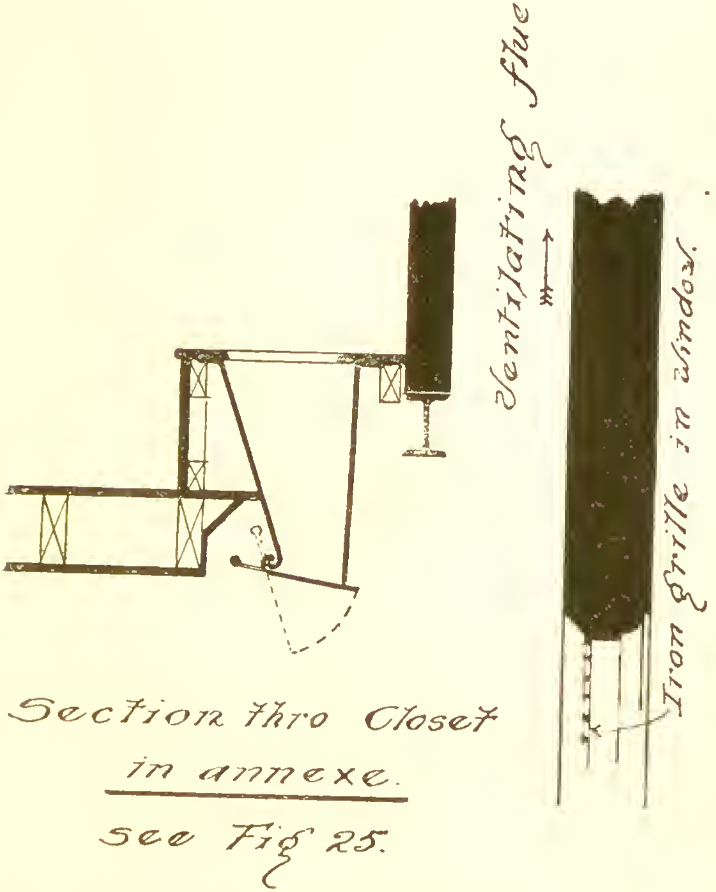


Ground Floor Plan

A, Closet for domestics. **B**, Dry catch of upper closet. **C**, Gutter for urine. **E**, Earth-box. **J**, Dwarf wall round **C** to exclude surface water. **L**, Ventilating shaft open at roof, sides, and end provided with air spaces.

The dry catch has many advantages over the pail system. In the first place, if from any cause the closet should not receive the usual daily attention no evil will result even though it be left for a week, whereas with the pail not only does it become full, but owing to urine being unable to escape and evaporate, it soon becomes offensive. The condition into which these pails have been permitted to fall owing to neglect has in a large measure brought the earth-closet into such bad odour. The large pails used in some places where the so-called dry system is in vogue are at the end of the week in a condition to poison anyone who is unfortunate

FIG. 27.



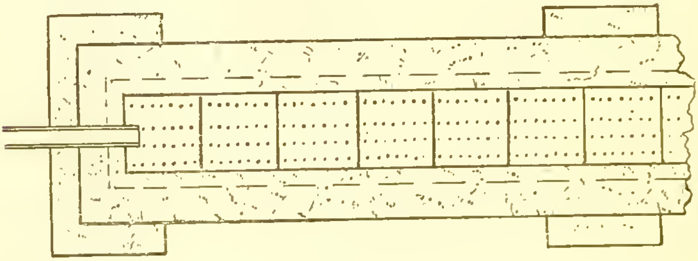
Section thro Closet in annexe.

see Fig 25.

enough to come within a yard of one of them. Where the closets are used extensively for micturition a trough must be formed, as shown in Fig. 26, into which the urine will drain. This trough must be filled with sawdust or earth and will only require to be emptied at intervals, varying, of course, with the number using the closet. It is important that rain-water should be excluded. The other midden closets in the garden are to be converted into dry-catch closets.

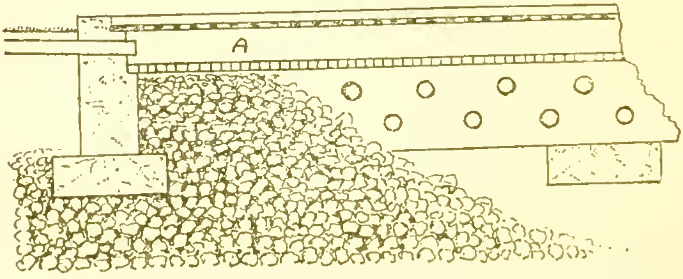
210. *The Bath.*—A short 2 in. lead waste-pipe is to be carried through the external wall, properly trapped and ventilated by a $1\frac{1}{2}$ in. anti-syphonage pipe carried through external wall (see Fig. 18), to deliver over a 2 in. galvanised cast-iron rain-water head the pipe from which is carried on across the arch and down to deliver into a half-round channel gutter which crosses the stable-yard and empties over an evaporating trench or filtration gutter to be described (see Figs. 28, 29, and 30). Dr. Poore objects

FIG. 28.



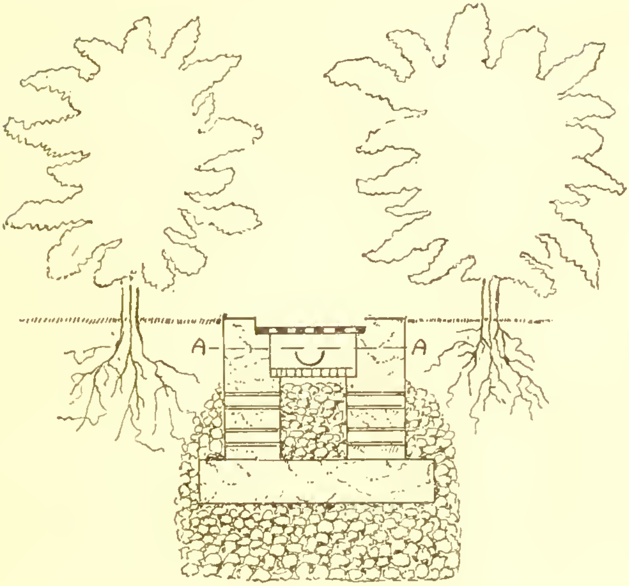
Plan.

FIG. 29.



Longitudinal Section.

FIG. 30.



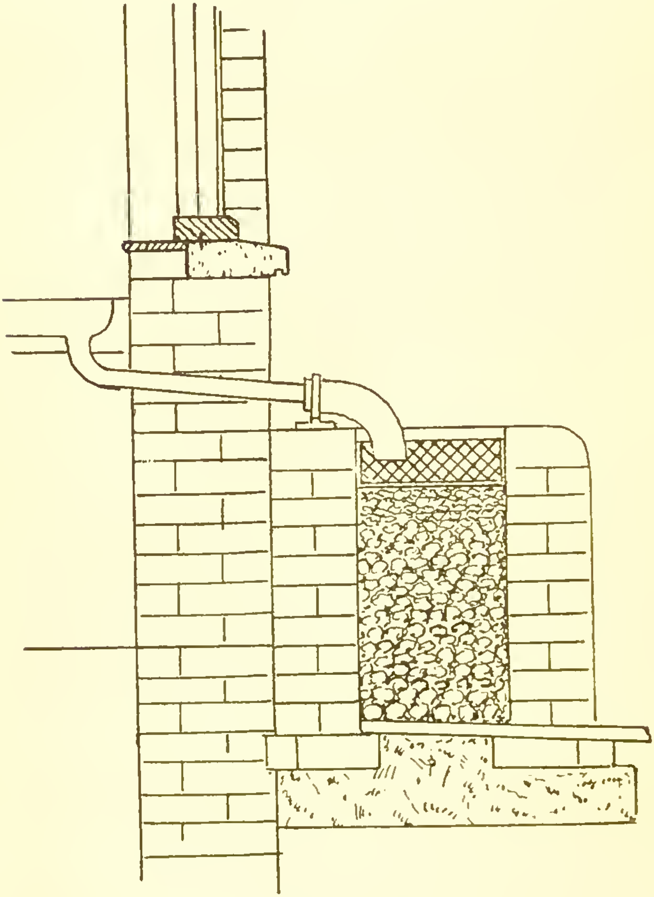
Transverse Section.

to the use of any trap under either a bath or sink as forming a receptacle for the development of putrefactive organisms, but it is doubtful if the absence of this trap compensates for the foul air that is then frequently drawn into a room through the waste-pipe in which the fatty matter from the soap accumulates and decomposes, though by keeping this pipe thoroughly ventilated much of this is avoided.

211. *The Filtration Gutter.*—To receive the slop waste water a trench should be formed on the other side of the stable-yard 15 ft. long, 2 ft. 6 in. wide and 2 ft. deep, the sides being lined with 9 in. dry brickwork or formed in concrete pierced with 2 in. agricultural pipes. This trench is filled to a height of some 12 in. with small stones, which offer a large evaporating surface. The stones may be covered with perforated tiles which permit some of the water discharged upon the surface to flow on and gradually become absorbed. A hedge is planted on either side of

the trench which also helps to absorb and evaporate the moisture. If desired the trench may be covered by an open iron grating.

FIG. 31.



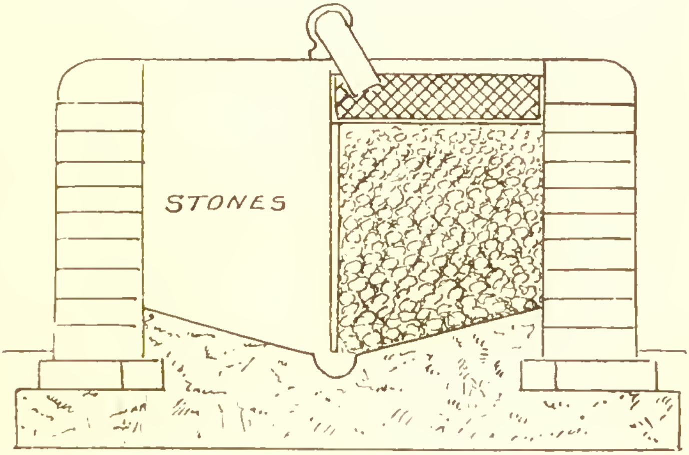
Transverse Section.

212. *A Slop Sink* properly trapped and fitted with anti-syphonage pipe is to be provided on the first-floor for the reception of the bedroom slops. The waste-pipe from this sink delivers over an open half-round channel which ulti-

mately connects into the evaporating trench. It is of course unnecessary to insist that the joints of these channels should be watertight excepting those immediately surrounding the house.

213. *The Scullery Sink* is treated somewhat differently. In order to keep the discharge from the waste-pipe above the ground level it may be necessary to form a raised platform by means of which the sink may be kept up an additional 14 in. or 15 in. (Fig. 31). The waste-pipe from this sink discharges over a brick-built chamber filled with small stones. This chamber measures about 3 ft. 3 in. by 1 ft. 3 in. by 2 ft. deep and is divided in the centre by a 1 in. slate division; the bottom and the sides of the two compartments thus formed are rendered in Portland cement. There is an outlet from each of these compartments into an open channel which is connected with the main system (Fig. 32). The actual waste-pipe from the sink is fitted with a swing nozzle which permits the discharge to be directed into each of the divisions of the chamber every alternate week, the water from the sink passing first through a wire straining dish, which arresst tea-leaves, potato-peelings, or any other solid refuse which it is necessary to

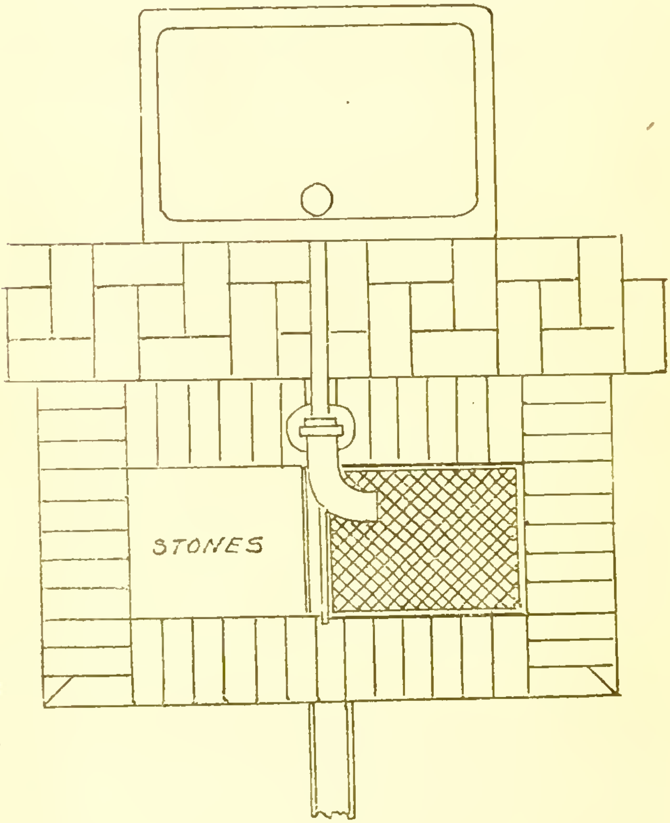
Fig. 32.



Longitudinal Section.

exclude (Fig. 33). The stones in the compartment at rest have to be lifted out and exposed to the air and sun about once a month for one or two days, but they do not require any other attention. This system of dealing with a scullery sink waste water has been found to answer admirably in a small establishment but its suitability for a large house or hotel discharging daily large quantities of fat and sand would be open to question unless provision were made to arrest the deposit. It is unnecessary to detail the plumber's work

FIG. 33.



Plan.

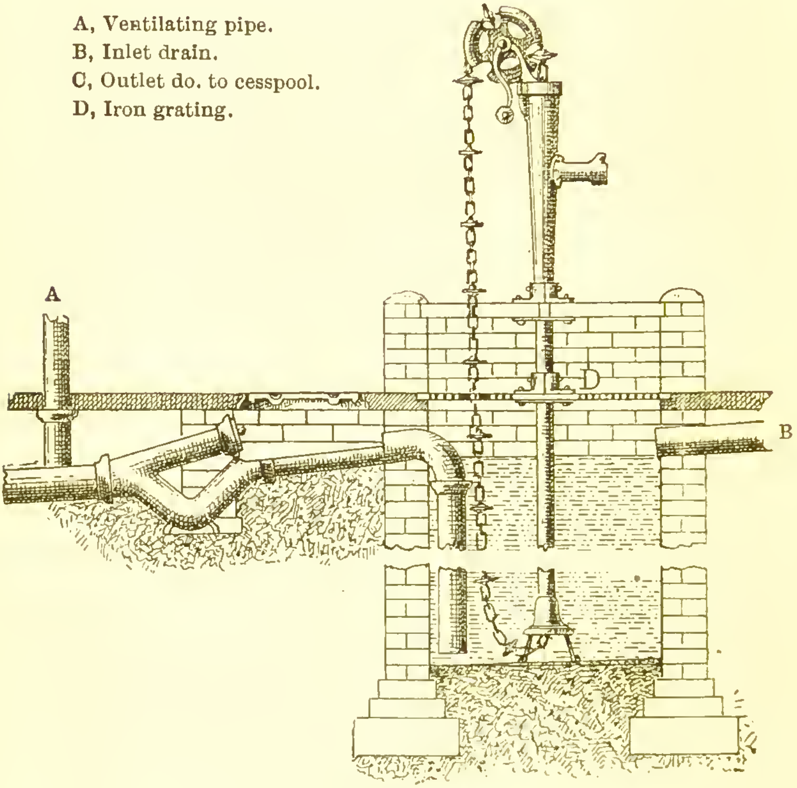
in connexion with the water-supply which is brought from the main supply to the hydrant situated at the corner of the farm buildings.

FARM BUILDINGS.

214. The farmyard, or more correctly the stockyard, presents some difficulty to the sanitarian in order to comply with the accepted practice and the requirements of the agriculturist. It is desired that the manure may be trodden by the stock into the straw laid down and the whole mass be intimately mixed. This produces a form of manure the effect of which when it is spread upon the land is more readily apparent than is the case where it is used prior to its assuming this rotten condition. It is, however, open to question whether the land receives the permanent benefit that would accrue to it if this manure was placed on it in a less advanced stage of decomposition. That the air emanating from these festering heaps is detrimental to the health of the cattle which winter on them cannot be questioned. The ground beneath is sodden with moisture and has no period of rest in which aeration might restore it to a condition capable of assisting nitrification, one result being that a large quantity of valuable liquid manure is not only lost but leaks away through the lower stratum of the soil with the chance of polluting any adjacent wells or streams to which it must eventually gain access.

Milch-cows may often be seen standing knee-deep in this liquid mess with their udders fouled by the filth, a condition of things by no means pleasant to contemplate. The floor of the farmyard, piggeries, and cow-stalls should be formed of some impervious material, such as brick, asphalt, or concrete and cement. Channels must be made to conduct the surface drainage into a manure tank (see Fig. 34) in the yard. This tank must not be of a large size, but should hold about 500 gallons and should be fitted with a chain pump so that the contents can be occasionally discharged over the manure in the yard to increase its value or into a cart for use elsewhere. This tank must have the sides carried up above the level of the surrounding straw and must be covered by an open iron grate. A 6 in. overflow-pipe like an inverted syphon from the bottom of this tank is to be carried into the main drain, with a syphon trap fixed close to the manure tank, as illustrated, and a 5 in. galvanised iron ventilating-pipe is to be carried up from the end of the drain as before described. The animals must, of course, be provided with open sheds in which to obtain shelter, but the practice of roofing over the whole of the stockyard in order to exclude rain is not much to be commended as it is apt to confine the emanations from the manure, nor is it necessary where the yard has an impervious bottom and is properly

FIG. 34.



A, Ventilating pipe.
B, Inlet drain.
C, Outlet do. to cesspool.
D, Iron grating.

Manure tank.

drained. The straw-yard cannot be looked upon with favour from a sanitary point of view. Dr. Poore, in his book upon Rural Hygiene, says that the farmer who buries his organic manure *directly it is produced* will lose nothing by waste. It will not give off ammonia to the air nor wil the juices be washed away by rain to the same extent as when it is left above ground to be a nuisance. There seems to be no doubt whatever that all heaps of manurial matter which give off ammonia and other gases to poison the air and perhaps do more serious mischief are allowing valuable matter to escape which ought to be undergoing oxidation in the earth. In fact, for the agriculturist stink means waste. The reasons why farmers allow putrescible matter to fester in heaps appear to be (1) that it has to be kept till the land is clear and circumstances permit of its being dragged to the fields; and (2) that when the matter is thoroughly rotten and most offensive *a more rapid and visible* result is produced, notwithstanding that the total result is probably less than if it had been applied to the ground at once. It is certain that putrescible matter intended for manure must waste more above ground than when buried immediately beneath it.

THE LOWER LODGE NO. 8.

215. The lower lodge No. 8 presents a striking example of the evils of cesspool drainage owing to the water-logged condition of the ground.

216. *Closet.*—There is a water-closet in the back addition which drains into a cemented cesspool, also receiving the waste water from the scullery sink and the rain-water from the roof. The cistern supplying the water-closet is fixed in the scullery, the sink in which is also supplied from the same source. This cistern is filled by means of a pump in the scullery which draws its supply from the shallow well in the garden. The pump is defective and the barrel is too large for the existing suction pipe.

217. *Recommendations.*—The closet, the cistern, and the pump will be entirely removed together with the stone sink. The closet, which is a small lean-to building next to the scullery, will be cemented throughout, including the floor, with Portland cement after the removal of the seat and the present wood floor, and a door fitted in the back wall of the closet under the new seat, which last is raised upon two brick steps and the whole finished as described for the servants' closet **AA** and **BB** (par. 144), with the exception of lining walls with tiles.

218. *Cesspool.*—No provision is made for any overflow from this cesspool as there is no place other than the stream into which such an overflow could be carried. The result of this is that the liquid contents escape into the surrounding ground, which is already saturated with moisture. During heavy storms the evil is, of course, more pronounced, the contents of the cesspool overflowing at the top on to the surface. Were it not that the well is favourably situated above instead of below the cesspool—that is, in the opposite direction to the flow of the subsoil water—very serious pollution must have ensued (see par. 31, Fig. 2).

219. *Recommendations.*—The contents of the cesspool must be entirely removed and the brickwork broken up and carted away, the hole being filled in with fresh earth.

220. *The Well.*—Owing to the isolated position of this lodge the water-supply will be taken from a shallow well about 12 ft. deep already existing, but it must be lined with tubes, as described in par. 33, the upper one standing up 18 in. above the ground level. The bottom of this well is to have a 12 in. layer of clean flints or rough stones; on the top of these stones about 6 in. of coarse gravel are placed, then come another 6 in. of fine gravel and 2 ft. of well-washed sharp sand, and, lastly, a few inches of fine gravel are laid to prevent any displacement of the sand by the action of the pump. The normal level of the subsoil water at this point being not more than about 3 ft. below the surface there will always be about 5 ft. of water in the well. Carry upon 4 in. of Portland cement concrete round the outside of the upper tube forming the well 9 in. of brickwork in cement, finished with a course of brick on the edge. Provide a circular wood cover to the top of the well, fitted with iron handles for lifting, and covered with 5 lb. sheet lead dressed down 3 in. all round the rim. The under side of the cover touching the top of the inner well tube is to be packed with a layer of asbestos sheeting so that it may fit closely and prevent the entrance of insects to the well. As the lodge occupies slightly rising ground on the north side of the valley which is drained by the stream and the lake and towards which the subsoil water flows, there is no danger of pollution to the shallow well, the soakage being away from it, whilst the depth of the well will not permit the water to be lowered so as to influence the drainage area in the neighbourhood of the soakage trench.

221. *Pump.*—Provide and fix in the scullery a 2½ in. barrel pump, carry a 2 in. stout lead suction-pipe from the same to the bottom of the new well, this pipe being laid in an open-jointed, tile-covered brick channel. This suction-pipe, just where it enters the well, is to be fitted with a lead collar so as to throw off any water that may have run back on the outside of the pipe. Care must be taken that the hole through which it enters the well is made quite sound so as to exclude any surface water.

222. *Sink.*—Provide and fix in the scullery an earthenware enamelled sink 2 ft. 6 in. by 1 ft. 8 in. with a 1¼ in. lead trap under the same. Carry the 1¼ in. lead waste-pipe through the external wall so as to deliver into an open channel-drain and provide the usual 1¼ in. anti-syphonage pipe.

223. *Slop-sink.*—In the external corner by the scullery door form on a concrete bed an enclosure constructed with blue Staffordshire bricks laid in cement, measuring 18 in. by 18 in. and 12 in. high, built in 4½ in. work and finished with half-round bricks on edge on the top, with the interior sloping into a half-channel bottom. Continue this channel to connect with that from the sink. This enclosure is to form a receptacle for the bedroom slops, which must not be thrown into the scullery sink. If the rain-water is not to be utilised the rain-water pipes can deliver into open channels connected with those already mentioned. The outlets from these channels are to be carried in a direction opposite to the well and are to be turned into a filtration gutter some 10 ft. long (see par. 211). By the side of which gutter a hedge is to be planted which will be found to assist evaporation greatly.

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